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U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY.

BULLETIN NO. 13.

REPORTS

OF

OBSERVATIONS AND EXPERIMENTS

IN

THE PRACTICAL WORK OF THE DIVISION,

MADE

UNDER THE DIRECTION OF THE ENTOMOLOGIST.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1887.

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17528—No. 13

LETTER OF SUBMITTAL.

DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., March 15, 1887.

SIR: I have the honor to submit for publication Bulletin No. 13 of this Division. This Bulletin comprises such of the reports of the agents of the Division for the season of 1886 as were necessarily excluded from the Annual Report for lack of space.

Respectfully,

C. V. RILEY,
Entomologist.

Hon. NORMAN J. COLMAN,
Commissioner of Agriculture.

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INTRODUCTION.

This bulletin contains all of the reports from the Agents of the Division for the season of 1886 with the exception of those from Mr. Coquillett and Mr. Koebele on remedies for the Cottony Cushion-scale of California (*Icerya purchasi* Maskell), that of Mr. Webster on insects affecting grains, which will be published in the Annual Report of the Department, and that of Mr. Ashmead on insects injurious to garden crops in Florida, which is reserved for the next bulletin.

Mr. Bruner's report on locusts in Texas during the spring of 1886 is interesting in its local bearing and from the similarity of this outbreak of non-migratory or partially migratory species in the far Southwest to that in the extreme Northeast described in our Annual Report for 1883.

Miss Murtfeldt's notes from Missouri, Mr. Alwood's report on some injurious insects from Ohio, and Mr. Bruner's report on Nebraska insects are simply short accounts of the prominent injurious insects of this particular season in their respective localities. Dr. Packard's fourth report on insects injurious to forest and shade trees contains an account of a new and important enemy of spruce cones, and considerable matter which is new and of interest both from the entomological and from the forestry standpoints.

Mr. Webster's experiments upon the effect of the puncture of certain plant-bugs were undertaken with a view of settling the disputed question as to whether these punctures are poisonous. The experiments in the main prove such a poisonous effect, and I may here state, without going into a general discussion of the subject, that while in Columbus, Ohio, in May, 1886, I found the immature forms of *Poecilocapsus 4-vittatus* blighting the young shoots of both Gooseberry and Currant, and that in this case the poisonous nature of the puncture was unmistakable. The punctured shoots were without exception blasted and distorted.

Mr. Alwood's tests with insecticides upon garden insects were undertaken as a continuation of those recorded in Bulletin No. 11 of the division, and will be of interest both on account of the new locality and on account of several new substances experimented with.

The apicultural notes from Mr. McLain form a portion only of his report for the season of 1886, and were excluded from the annual report for want of space. The portion on bees *vs.* fruit is in the main an account of a repetition of the experiments detailed in the Annual Report for 1885. The results are corroboratory, but not absolutely conclusive of the inability of bees to injure fruit, in that the conditions were not varied sufficiently and that the fruits were substantially the same kinds as used last year.

C. V. R.

REPORT ON LOCUSTS IN TEXAS DURING THE SPRING OF 1886.*

By LAWRENCE BRUNER, *Special Agent.*

LETTER OF TRANSMITTAL.

SIR: Herewith is submitted a brief report of a trip to Washington County, Texas, and surrounding regions, made under your instructions for the purpose of investigating the locust plague of that section and reporting upon the same.

You will see from my notes and the specimens which accompany the report that the chief species causing the damage is, as you supposed, not *Melanoplus spretus* but *M. differentialis* or a closely allied form; and that it can be much more easily handled than can the migratory locust of the Northwest.

Immediately upon the receipt of your letter (April 16) containing the instructions, I arranged to leave by the first train (April 17). Arriving in Houston on the 20th and making all necessary preliminary arrangements, Dr. Flewellen and myself proceeded the next morning to the seat of trouble, which was reached late in the afternoon of that day.

Upon examination myriads of the young locusts were found on the plantation of the doctor's brother, Maj. J. P. Flewellen. These were chiefly confined to the edges of the fields and along the ravines where they had congregated upon the weeds.

After spending a few days in experimenting with poisons and other agencies for killing them, I returned to Houston for mail containing any possible further instructions. From here I went to Galveston, where I wrote a short communication for the *News*, giving remedies and urging co-operation in the efforts in destroying the plague. A copy of this article accompanies the report.

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* Our attention was called to the locust visitation in Washington County, Texas, in March of the present year by a letter received from Dr. R. T. Flewellen, of Houston, which reads as follows:

WASHINGTON COUNTY, TEXAS,
March 22, 1886.

DEAR SIR: This and many other localities of Texas had the crop of corn and cotton destroyed by grasshoppers, and I herein send you a small paper box of eggs taken from the ground to-day for your examination. This locality, 4 miles south of the old town of Washington on the Brazos River, lost not less than 20,000 bushels of corn and about 2,000 bales of cotton by the ravages of the pest, and judging from the vast quantities of eggs seen to hatch, the destruction of last will be repeated this year unless timely aid comes to the relief of the unfortunate planter. Hence this appeal to you. It is hoped that you will send some expert of your department to this immediate locality to learn the habits, species, and correct classification of the insect, and inaugurate some means for their destruction, for if not arrested this locality is doomed.

* * * * * * *

Very truly,

R. T. FLEWELLEN.

Prof. C. V. RILEY,
Washington, D. C.

We accordingly had Mr. Bruner visit the region in question with instructions to learn what he could concerning the extent of injury, the species concerned and their habits, and to experiment with such remedies as would aid the planters in saving the crops.

After leaving Galveston I visited various localities surrounding the immediate region infested to ascertain the exact area over which the locusts had hatched in injurious numbers, thereby anticipating your orders of April 29, which reached me at Austin on the 5th of May. From Austin I returned to the plantation of Mr. Flewellen in order to ascertain how the warfare was progressing in that neighborhood, and what the prospects were for the production of a crop this year. Upon my arrival I found a decided reduction in the number of hoppers, and a correspondingly brighter and more hopeful feeling among the planters of the stricken area. I also learned of another locust that appeared to be increasing very rapidly among the forests of post oak lying between the towns of Washington and Brenham. This very likely will prove to be an undescribed species, belonging somewhere between the genera *Melanoplus* and *Acridium*.

After sperding several days in this locality, I returned to my home at West Point, where I arrived on the 14th of the month.

Very respectfully,

LAWRENCE BRUNER.

Prof. C. V. RILEY,
U. S. Entomologist, Washington, D. C.

I visited the region indicated in Dr. Flewellen's letter of March 22, arriving there on the evening of April 21, to find that the young had already hatched and were then nearly or quite three weeks old. Upon examination but few of these were found scattered over the cultivated fields, while the majority of them were still confined to the weed patches at the outer edges in ravines, along "turn rows" and in fence corners. That evening, after a short consultation with the neighboring planters, it was decided that immediate warfare begin, as no time should be lost if advantage was to be taken of the position which the enemy occupied. Accordingly, early the following morning, a team was dispatched to town for poisons and other munitions of war. While some present favored poisoning, others opposed this mode of warfare as dangerous and impracticable; but, as they could suggest no substitute, it was finally agreed that poisoning should be tried. This was agreed upon chiefly because all were supplied with the apparatus necessary for its application, and were accustomed to its use in fighting the Cotton Worm (*Aletia xylina*). I also proposed the use of coal tar and kerosene pans, and ordered the material for the construction of a trial machine. The following morning we started out over the plantation of Major Flewellen on a tour of inspection, only to find the majority of the eggs already hatched and the young locusts in their second and third stages. After digging for several hours and finding but a couple of unhatched eggs and no egg parasites, it was decided to devote the future to the destruction of the larvæ before they began spreading over the crops, notwithstanding the fact that you wished me especially to devote much of my time in digging for egg parasites.

By careful inquiry from old citizens I learned that ever since the wartimes grasshoppers have occasionally appeared in unusual numbers at isolated localities throughout portions of Central Texas, and especially in the immediate neighborhood at present overrun. When this was

the case, crops invariably suffered to a lesser or greater extent from their depredations. These visitations were so limited in extent and inconspicuous in their nature that but little attention was paid them at the time. There were other insect enemies that were attracting notice and required the attention of the planters, whose chief crop had been cotton. The Cotton Worm (*Aletia xylina*) had so increased in numbers as almost to render the growing of cotton an impossibility; but, owing to the perseverance of those interested, that insect has at last been reduced to such an extent as to be under control. Until within the past three years these grasshopper or locust depredations escaped popular notice (save during the visitation in the Fall of 1876 of the migratory species). Since this time, however, their increasing numbers and frequent damage to crops have been too great to be overlooked even by the most unobserving. They have appeared at widely separated localities, and although not committing general injury are known to have eaten away several of the outside rows of cotton and corn in fields bordering waste lands and ravines grown up with weeds and other rank vegetation. Not until last year, however, did the plague reach such a magnitude as to cause alarm; and this only after the total destruction of crops upon plantations situated in different localities and in adjoining counties.

Referring to notes taken while in the field, I find the following remarks: "There appear to be several species of the locusts which are causing the trouble here, and all seem to have had similar egg-laying habits. In looking about I find the larvæ of *Melanoplus differentialis* or *M. robustus*, *M. angustipennis*, *M. atlanis*, and *Acridium frontalis*. The last three species are in about equal numbers, while those of the first are by far the most numerous, and this is the only one which is charged with last year's depredations. I am not quite positive whether the large species is *M. differentialis* or *M. robustus*, as these two species are very nearly related, and I have never seen authentic larvæ of the latter. To-day (April 23) I found an old specimen of a male *robustus*, and was assured that it was one of the genuine offenders, while yesterday the femora of *differentialis* were pointed out to me as having belonged to 'the very kind'."

During my sojourn in the infested region I observed *M. atlanis*, fully fledged, quite frequently, while walking about the fields, while others, with those of *M. angustipennis*, were still in the pupal stage. These latter, with those of *Acridium frontalis*, were exceedingly common, and together nearly or quite equaled in number those of the larger species. These three, while not always mingled with the former, were generally to be found with them; especially was this the case upon rather damp ground at the edges of ravines and grass patches, and also in fields of small grain.

While the Rocky Mountain or Migratory Locust prefers rather solid soil upon somewhat elevated open fields and closely grazed pastures for

depositing its eggs, all of these species now infesting Central Texas appear to find more suitable conditions among rank herbage for the deposition of their eggs and subsequent development of the young larvæ. The large species especially finds the protected roots of grasses and corn best adapted to the sheltering of its eggs, and almost invariably selects the varieties which grow in clumps for this purpose. In digging I have found as many as 8 or 10 egg-pods inserted among the root-stalks of a single clump of grass. Possibly the sheltered nature of these eggs protects them from the numerous parasites which attack those of the Migratory and other species which deposit in the unprotected ground. It is asserted by different persons in this region that the present species lays an average of 150 eggs to the pod, which, judging from the fragments of egg-shells found by digging, is nearly correct; at any rate the estimate is not too high. Egg-depositing with this species commences rather later than with some of the other representatives of the genus, but just at what date I did not learn. There is but a single pod formed by an insect, the entire complement of eggs being deposited at once.

The larvæ commence hatching during the latter part of March and continue to appear up to the middle of April, according to the forwardness or backwardness of the season. Wet warm weather favors the hatching, while dry weather rather retards the process. The young molt five times, at intervals of from 12 to 20 days, according to the condition of the weather. Dry weather with hot days retards, while damp or wet weather favors this process among insects by keeping the exuviæ pliable during molting, as well as in furnishing the necessary moisture required in growth. The winged or mature insects appear about the middle of July or a little earlier and begin to couple soon afterward, thus completing the cycle.

Their mode of attack does not differ greatly from that of *M. spretus*, save in that the latter begin upon the crops immediately after hatching, while these species do not. They wait until they are from three to four weeks old before venturing far from the places of hatching. Like that species they have the habit of huddling together upon plants and among grasses and débris during cool nights and on cloudy days. This appears to be a trait common to all insects when present in large numbers, and must be the result of some special instinct. When about half-grown the larvæ become pretty well scattered over the fields and do not hop back to the weed patches on the outskirts in the evening, as they do while younger and when first beginning their attacks upon the crops. The molting is the same as with other locusts, and need not here be redescribed. The grown hoppers do not migrate by flight, but do sometimes move in concert in certain directions by jumping. This can hardly be termed migration, since the change of location is merely performed for the purpose of obtaining food, while the act of migrating is towards obtaining more decided results. When feeding they can be driven like other locusts, and this trait in their nature has been taken advantage

of at different times and by many of the planters as a means of partial protection to the crops.

It is sometimes quite a difficult matter to account for the rapid increase of certain insects during a series of seasons that for years before have scarcely appeared in numbers sufficient to be noticed. However true this assertion may be, I think the rapid increase in the present instance can be readily accounted for, and has its direct causes partly in the negligence of the planters over the area now suffering and partly through other and indirect but favoring circumstances. It has already been ascertained that all of the species which are combining in the present injury are partial to rank vegetation, and find the most favorable conditions for their egg-laying and subsequent development in the waste land at the borders of cultivated fields, in ravines which run through cultivated ground, and in neglected grounds which were at one time under the plow. Everywhere in this locust area do we find great neglect in this respect. There are not only large fields lying idle which were once cultivated in cotton, but also wide borders adjacent to ravines and gullies which have been permitted to grow up in bunch grasses and weeds. Each of these features is of too common recurrence, thus giving this and other insects of like nature ample harbor and room for multiplication year after year. This is the prime cause, but from inquiry it cannot be disputed that there are several other agencies which have aided in bringing about the present state of affairs. These are, primarily, the comparative scarcity of insectivorous birds, and secondarily the comparatively dry summers for the past three years. While the bird question cannot easily be remedied at once, or the seasons changed so as not to favor the increasing hoppers, there can be a great deal accomplished by clearing up these waste places and putting them once more under the plow. The dry seasons have aided the increase of the locusts by diminishing their natural enemies. These are chiefly soft-bodied insects, very delicate in structure, that are dependent to a much greater extent than the locust is on moisture for their development and subsequent career. It stands to reason, therefore, that dry seasons, while not materially affecting the more hardy nature of the locusts, are very injurious, if not altogether fatal, to insects whose organs are so delicate as are most of these parasitic forms.

Up to the present season but little or nothing has been done by the planters to protect their crops from the ravages of these locusts or towards diminishing their numbers. True, some of them tried to save their crops by driving the locusts off after they were fully matured and could fly. While this remedy will sometimes save a portion of a crop, it is only transient in its result, and must be repeated each day several times. It is also a remedy that works better with the migratory species than with the non-migratory forms that seldom fly more than a few yards at a time. To save crops from locust ravages the main object to be kept in view is, or rather should be, the destruction of the

pest, and not merely a transient removal of it. If the insects are merely kept agitated while in the fields this does not prevent them from proceeding to the outskirts and depositing their eggs in the waste places heretofore mentioned, and thereby rendering the production of crops the ensuing year equally uncertain, and even, with favoring conditions, tenfold more so.

When I first visited the region infested, I learned of some efforts at poisoning the larvæ with arsenic and Paris green. These had been tried merely as experiments, and thus far had proved but partially successful. The poisons in every instance had been applied in too large quantities for the mixtures used, and resulted in the killing of the vegetation over which they had been distributed. Where this was the case, the hoppers escaped with little injury. These mineral poisons only take effect when taken internally with the food, and when the vegetation has been killed the young locusts will not eat it, but hop away to seek that which is fresh. Finding this to be the case, a series of experiments was instituted in order to ascertain just what proportions of the poisons were necessary in order to obtain the best results and not to kill the vegetation. By inquiry it was learned that of the arsenic the following solution had been used: to one barrrel (47.9 gallons) of water in which two quarts of molasses had been stirred, 12 ounces of the poison were added. The latter had first been boiled in a little water, with a pound or more of carbonate of soda, for about an hour in order to dissolve it. We therefore decided that the future experiments should be made with less poison to the barrel of water, and accordingly a half pound was substituted. This mixture also proved too strong for the vegetation. After continued experiments it was finally decided that from 4 to 5 ounces of the poison to the barrel of water gave by far the best results, and did not injure the vegetation unless put on too thickly or in too coarse a spray. Bright sunshine during spraying appeared to render the poison more injurious to the vegetation. A second spraying over the same grounds also had the same effect as the stronger mixtures. Light rains did not materially diminish the efficacy of the poisoning. The results of arsenious poisoning are not immediate upon the hoppers, but first show after about twenty-four hours, and prove fatal in about thirty-six to forty hours. When the first examination was made after the application (twenty-four hours afterwards) it was found that most of the larvæ had left the weeds and were found creeping and jumping about in a rather sluggish manner upon the ground underneath. No dead ones were to be found at this time. In examining the same locality a day later, a great many dead were found, also many others that were very sluggish, while but few really active ones were to be found. On the morning of the third day I counted upon 1 square foot of surface between fifty and sixty dead, and a few others were present that must certainly have followed before the expiration of another twenty-four hours.

This poison is best applied with a rather powerful force-pump, using a very fine spray, otherwise the vegetation will blister and much of the fluid be wasted by falling upon the ground. The finer the spray the more evenly the poison can be distributed, and hence a correspondingly better result will ensue. Where comparatively large areas are to be poisoned the best plan is to have two or more barrels, or, what is better still, a tank holding a hundred or more gallons of the poisoned water, mounted upon a wagon and drawn through the field with a team of horses or oxen. Always poison by going against the wind instead of with it, otherwise there is danger of poisoning both the team and the persons operating the pump. It should also be remembered that a muzzled beast is less liable to eat the poisoned vegetation than one without a muzzle. Again, poisoning should be done only upon such grounds as are never grazed, or over which stock is not permitted to run. Poisoning can only be done with safety in regions where fields are fenced, and upon such vegetation as will not afterwards be used as food for animals or man. While rains may wash off most of the poison from weeds, they never can do this from grasses and grains where the blades are fastened to the stem in such a manner as to catch all the rain which falls upon them and carry it to the body of the plant.

Paris green is used diluted with wheat flour or wood ashes, and applied by dusting it upon the vegetation by means of a fine meal-sieve. The proportions giving the best results as stated to me were 12 ounces of the green to about 20 pounds of flour. Some add one pound of very finely-powdered resin, which they claim acts as a sort of glue, causing the material to adhere to the vegetation. Great caution is also necessary in using this poison, both in its application and afterward in keeping stock away from the vegetation to which it has been applied. The best time for applying this remedy is in the morning while the dew is still on the vegetation and before the wind arises. While a few of the planters in the vicinity of Washington and Navasota seemed to think this remedy superior to the arsenic, I did not find it so upon Mr. Flewellen's plantation, where it was tested several times. Wherever used, it is true, the hoppers disappeared, but an examination revealed but few dead ones upon the ground. My opinion is that they only moved to other localities where the poison was not put. This I am pretty certain of, for frequently large numbers of the larvæ were observed adjacent to such localities one day where there had been none the day before. Vegetation also suffered from the effect of the poison.

In using poisons I would recommend the spray rather than the dry application. The sirup or molasses adds to the efficacy of this latter by enticing the hoppers to eat, since they are exceedingly fond of sweets. Poisoning is undoubtedly a good remedy against locusts and other injurious insects in countries where every field is fenced and where no stock is permitted to roam about. Where there are no fences, however, and stock roams at will over fields and along roadsides, its use

is out of the question. There are also numerous instances in fenced districts where its use is impracticable and out of the question; as, for example, in pastures and grain-fields as well as in the garden. In these latter instances, therefore, it is necessary that other remedies be adopted. I therefore suggested the use of the coal-tar and kerosene pans and the various other machines and contrivances which have been used with success in other locust districts in times past. As a sample and illustration of their use I had one of these constructed, and had the satisfaction of seeing it adopted by almost every planter in the immediate neighborhood, as well as by others throughout the region afflicted. While this latter remedy or contrivance did not meet the approval of some of the larger planters, it was very popular with the colored population, who are exceedingly superstitious concerning the use of poisons of all kinds. It was also quickly adopted by persons of limited means, or where the locusts were confined to small patches and could be readily destroyed in a few days with a small machine dragged over the ground by hand.

In addition to the foregoing remedies one gentleman told me of a plan he had adopted for destroying the hoppers upon his place. It was about as follows: Having noticed that a certain piece of neglected ground had been largely used by the locusts last fall for depositing their eggs, he decided to plow it up this spring and, if possible, prevent them from hatching. When plowing began it was found that most of the eggs were thrust among the roots of large grass clumps. He therefore mustered all hands together and set them to gathering these clumps of grass and hauling them into piles which were afterwards set on fire and burned, thus destroying the locust eggs which they contained. No less than nine wagon loads of the grass clumps were thus gathered and burned, and this evidently did much good. Others who have recognized the insectivorous nature of fowls, and especially of the guinea-hen and turkey, have begun rearing these in large numbers. I also suggest to the planters in general that they protect the quails and quit shooting them for several years, since they, too, are of great aid as insect destroyers.

At this time locusts are present in damaging numbers in the following counties as nearly as I could ascertain by inquiry and travel: Washington, Burleson, Lee, Fayette, Austin, Grimes and Waller, and of these only Washington, Austin, Grimes and Waller have reported the loss of crops during last year from their ravages. This section lies just between the two "cross timbers" of east Central Texas and borders the prairie country. Judging from the timbered nature of this portion of the State, the climate as a rule must be rather more humid than it has been during the past few years, and consequently cannot always be overrun by locusts, if, as we understand it, aridity is favorable to the rapid increase of these insects. With the present warfare against them, if continued during the spring and summer into the fall, there certainly

cannot be much danger of future depredations from locusts. Still I would suggest to the inhabitants of this and adjoining regions to keep on the alert, and wherever and whenever threatened to waste no time but to try and control them at once.

Although the loss of crops has been limited to comparatively small areas throughout these counties, nevertheless the damages sustained will aggregate more than might be imagined. As an example, we need only quote a few lines from Dr. Flewellen's letter where he writes: "This locality, 4 miles south of the old town of Washington on the Brazos River, lost not less than 20,000 bushels of corn and 2,000 bales of cotton by the ravages of the pest." When we add to this the losses sustained at other localities throughout these counties, and also those on other crops, we have before us quite formidable figures.

In closing my report, it might be thought proper for me to give my opinion as to the possible results of this summer's brood of hoppers. This can be done in very few words. Possibly in addition to a few outside rows, a few fields of cotton and corn will be taken in places where the weed patches were destroyed prematurely, thereby scattering the larvæ over the fields while the crops were still very small and tender. This I know to have occurred in several instances where it was thought that by destroying the weeds the little hoppers would also perish. Aside from this there need be but few complete failures on account of locust depredations.

THE POST OAK LOCUST OF WASHINGTON COUNTY, TEXAS.

In addition to the several species of locust that have been mentioned in the preceding pages, last summer for the first time another species of locust was noticed in vast numbers among the post oak timber lying between the towns of Washington and Brenham, in Washington county. These were so numerous in one locality that they completely defoliated the trees of the forest, even to the very topmost twigs. The region occupied by this insect, although not over a mile and a half in width by 7 or 8 miles in length, is sufficiently large for the propagation of swarms capable of devastating a much larger area during the present spring and summer, and by another year to spread over several of the adjoining counties.

Although there is at present no apparent injury to the trees thus defoliated last year, and now in progress again this year, there can be no question as to the final result if these attacks are continued for several years longer. The trees will eventually die. While up to the present time this locust has shown a decided arboreal habit, it may, and undoubtedly will be, obliged to seek food in the adjoining fields when compelled to do so through lack of its present diet, which is rapidly disappearing before the hungry myriads of young locusts.

Notwithstanding the great numbers of the foregoing described species which together have combined in injuring the cotton and corn crops

throughout this and adjoining counties, it is my opinion that the present species is more to be feared in the future than they, on account of its arboreal nature and the difficulty of getting at it in order to destroy it. To kill these locusts either while feeding among the foliage or "roosting" upon the topmost boughs of the tall trees would be next to impossible. On the other hand, the other species are easily to be gotten at and destroyed, as just shown.

The habits of this locust, as nearly as I was able to learn through inquiry from others, and by personal observation, are briefly as follows:

The egg-pods are deposited in the ground about the bases of trees or indifferently scattered about the surface among the decaying leaves, &c., like those of all other ground-laying species. The young commence hatching about the middle of March and continue to appear until into April. After molting the first time and becoming a little hardened they immediately climb up the trunks of the trees and bushes of all kinds and commence feeding upon the new and tender foliage. They molt at least five or six times, if we may take the variation in size and difference in the development of the rudiments of wings as a criterion. The imago or mature stage is reached by the last of May or during the first part of June.

The species is very active and shy in all its stages of growth after leaving the egg. The larva and pupa run up the trunks and along the limbs of trees with considerable speed, and in this respect differ considerably from all other species of locusts with which I am acquainted. I am informed that the mature insects are also equally wild and fly like birds. They feed both by day and night; and I am told by those who have passed through the woods after night when all else was quiet, that the noise produced by the grinding of their jaws was not unlike the greedy feeding of swine.

Aside from its arboreal nature there is but a single instance mentioned of its preference to growing crops. This was a small field of either cotton or corn, or perhaps both. If the nature of the crop was told me at the time I have forgotten. At any rate the crop of one or the other of these two staples grew in a small clearing in the very midst of the most thickly visited area. The mature insects alone were the offenders in this instance. During the day-time they would leave the trees in swarms and alight upon the growing crop and feed until evening, when they would return to the trees. If, during the day, they were disturbed, they immediately took wing and left for the tops of the surrounding trees to return shortly afterward.

The exact classification of this locust has not yet been fully ascertained, since no mature specimens were to be obtained, or, to my knowledge, are contained in any of our American collections. The larvæ and pupæ collected, however, would indicate a relationship to both the genera *Melanoplus* and *Acridium*. It appears to be congeneric with an

undescribed short-winged form, thus far only taken in Missouri, which lives among and feeds upon the oaks only of that region. The present species is also evidently undescribed, unless the mature insect should differ widely from the preparatory stages herewith presented. It is popularly known in that region as the "Red-legged hopper" of the post oaks.

The larvæ and pupæ are of rather bright color, giving them a gaudy appearance. The ground color of the body is dark wood brown deepening into black along the sides of the pronotum and the apex of the posterior femora. The head for the most part is of a bright lemon yellow, while the pronotum is of the same, varied by streaks and blotches of the brown. The antennæ and posterior femora are red internally, dimly banded with yellow and brown on the external face, through which the red color of the inner side can be plainly seen. The feet and tarsi are also dark. The pupæ average almost an inch in length and are rather robust in form, with short, broad heads and powerful jaws

FOURTH REPORT ON INSECTS INJURIOUS TO FOREST AND SHADE TREES.

By Dr. A. S. PACKARD, *Special Agent.*

LETTER OF TRANSMITTAL.

PROVIDENCE, *November* 1, 1886.

SIR: I herewith submit my report on insects injurious to forest trees, based on observations made during the past season in Rhode Island, Maine, and New Hampshire. This report contains observations on the Spruce Bud-worm, a new enemy to that tree, with notes on other forest insects. Other notes on incomplete larval histories do not necessarily appear until they have been completed.

Respectfully yours,

A. S. PACKARD.

Prof. C. V. RILEY,
U. S. Entomologist.

THE SPRUCE AND HACKMATACK WORMS IN 1886.

During the past season, as in 1885, no traces of the caterpillar or moth of *Tortrix fumiferana*, formerly so destructive to Firs and Spruces, were discovered. The moths must be now as rare as before 1878. Great progress has also been made by the younger growth of these coniferous trees in repairing the desolation caused by the attacks of this worm.

The Larch Saw-fly was, on the other hand, found to be still not uncommon. It was observed July 1 at Brunswick, Me., locally, the worm having freshly hatched upon a few trees, but it did not do any more harm than the previous year.

During the early part of September, however, it was observed in abundance along the Cherry Mountain road from Fabyan's to Jefferson, N. H., a few miles north of the White Mountain house. The Larches had been ravaged rather severely and many of the worms were still lingering on the branches, feeding upon the leaves; while many young trees had been stripped, wholly or in part, of their leaves. Some dead Larches were also to be seen.

We call attention below to a Phycid caterpillar which was observed in Maine preying upon the young cones of the Spruce, no lepidopterous insect with similar habits having before been observed.

We have also given more attention than formerly to the insects infesting the Willow and Alder, as these trees are the prolific source of many species which spread from them to other forest as well as to ornamental

and shade trees. While the Willow has until recently been useful as a shade tree, when standing by the horse-trough or by the well, an occasional Weeping Willow being seen in towns, a new value is attached to the tree for the salicylic acid extracted from it, and in the Southern States there have already been established extensive plantations of willows, the twigs and branches being cut and gathered for the extraction and manufacture of this valuable remedy.

The number of species of insects affecting the Willow in Europe is said by Kaltenbach* to amount to three hundred and ninety-six; of these ninety-four are beetles and two hundred and fifteen moths and butterflies; while the European Alder supports one hundred and nineteen species of insects of different groups.

THE SPRUCE CONE-WORM.

(*Pinipestis reniculella* Grote.)

This is the first occurrence, so far as we know, of a caterpillar preying upon the terminal fresh young cones of the Spruce. We have previously† called attention to the Spruce Bud-louse (*Adelges abieticolens*) which deforms the terminal shoots of the Spruce, producing large swellings which would be readily mistaken for the cones of the same tree. Another species of Bud-louse (*Adelges abietis* Linn.), which appears to be the same as the European insect of that name, we observed several years since (August, 1881) in considerable numbers on the Norway Spruces on the grounds of the Peabody Academy of Sciences at Salem.

The species of caterpillar in question was observed, August 24, in considerable numbers on a young Spruce 10 to 20 feet in height at Merepoint on Casco Bay, Maine. The cones on the terminal shoot as well as the lateral upper branches, which when healthy and unaffected were purplish-green and about $1\frac{1}{4}$ inches long, were for the most part mined by a rather large Phycid caterpillar. The worm was of the usual shape and color, especially resembling a Phycid caterpillar not uncommon in certain seasons on the twigs of the Pitch Pine, on which it produces large unsightly masses of castings within which the worms hide.

The Spruce Cone-worm is usually confined to the young cones, into which it bores and mines in different directions, eating galleries passing partly around the interior, separating the scales from the axis of the cones (Fig. 1). After mining one cone the caterpillar passes into an adjoining one, spinning a rude silken passage connecting the two cones. Sometimes a bunch of three or four cones are tied together with silken strands; while the castings or excrement thrown out of the holes form a large, conspicuous light mass, sometimes half as large as one's fist, out of which the tips of the cones are

FIG. 1.—Single pierced cone (original).

* Die Pflanzenfeinde aus der Klasse der Insekten, 1874.

†Guide to the Study of Insects, p. 523, and Bulletin 7, U. S. Ent. Comm., p. 234.

seen to project (Fig. 2). Besides these unsightly masses of castings, the presence of the caterpillars causes an exudation of pitch, which clings in large drops or tears to the outside of the adjacent more or less healthy cones. Where much affected the young cones turn brown and sere.

FIG. 2.—Mass of infested cones (original).

The same worms had also attacked the terminal branches and twigs of the same tree, eating off the leaves and leaving a mass of excrement on one side of the twig, within which they had spun a silken gallery in which the worm lived.

On removing the bunches of diseased cones to Providence, one caterpillar transformed in a warm chamber into a moth, which appeared the end of October; its metamorphosis was probably accelerated by the unusually warm autumnal weather. All the others had by the 1st of November spun within the mass of castings a loose, thin, but firm, oval cocoon, about half an inch long and a quarter inch wide, but the larvæ had not yet begun to change to chrysalids. Whether in a state of nature they winter over in the larval state within their cocoons, or, as is more likely, change to pupæ in the autumn, appearing as moths by the end of spring, remains to be seen.

The chrysalis is of the usual Phycid appearance, rather slender, but with the abdominal tip blunt, with no well-marked cremaster or spine, though ending in the usual six curved stiff bristles, by means of which it hooks onto the walls of its cocoon, thus maintaining itself in its natural position.

I only found one tree next to the house thus affected by this worm. It is probable that in a dense spruce growth the trees would be less exposed to the attacks of what may prove a serious enemy of shade spruces. The obvious remedy is, to burn the affected cones and mass of castings late in summer.

FIG. 3.—Spruce Cone-worm (enlarged, original).

DESCRIPTIVE.—*Larva.* (Fig. 3.)—Of the usual Phycid form; the head and prothoracic shield deep amber-brown; the body reddish carneous or amber-brown, with a livid hue; a faint, dark, dorsal, and a broader, subdorsal line; piliferous warts distinct; each segment divided into a longer anterior and shorter, narrower, posterior section, bearing two dorsal piliferous warts, besides a lateral one. Length 16^{mm}.

Pupa.—Of the usual Phycid appearance; rather slender, the abdominal tip blunt, with six long slender up-curved bristles. Length 9mm.

Moth. (Fig. 4.)—1 male. Fore-wings long and narrow, stone-gray, with no reddish or brownish tints. Head, palpi, and body dark gray with white scales intermixed. Fore-wings dark and light gray; a broad basal light pitch; before the middle of the wing a white zigzag line composed of a costal and median scallop. A square whitish distal patch, and half way between it and the outer margin is a narrow white zigzag line inclosed on each side by a dark border, the line being deeply angulated three times. Edge of the wing next to the base of the fringe deep black, interrupted by narrow pale gray spots. Fringe dusky, with fine white scales. Legs banded with black and gray. Hind wings pale gray. Expanse of wings 22mm; length of body 10mm. (Identified by Prof. C. H. Fernald.)

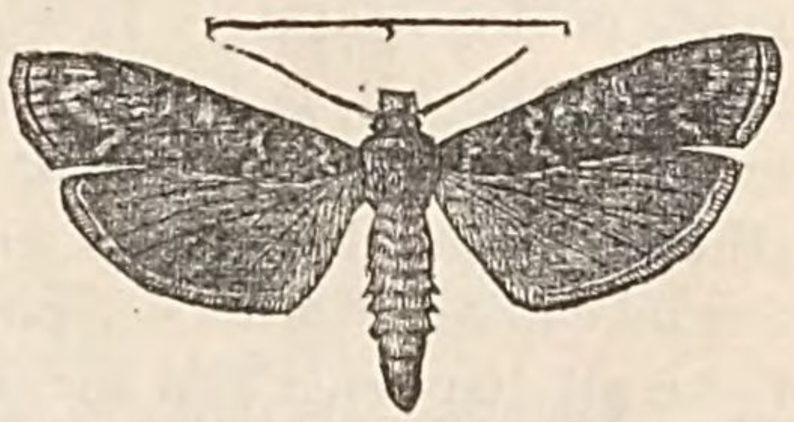

FIG. 4.—Moth of Spruce Cone-worm (enlarged, original).

THE GREEN-STRIPED PHYCID WORM.

(*Meroptera pravella* Gr.)

This a common insect on the Willow, occurring at Brunswick, Me., August 20, and through the month. It spins a web on the under side of the leaf, and pupates from the 15th to 20th of September, the moth in confinement appearing (in the breeding cage at Providence) the end of May (the 25th–31st). The caterpillar, which is longitudinally striped with light and dark green with black slashes on each side of the head, varies somewhat; in some there are only four slashes on the head, with no other markings. The moth differs from *Phycis rubrifasciella* on the Hickory in having no cross-band of raised scales, while the insect is much darker, and the palpi are twice as broad.

DESCRIPTIVE.—*Larva.*—Body of the usual form, tapering from near the head to the end. Head of the usual size, not quite so broad as the prothoracic segment; green, slashed vertically and mottled with large and small brown or jet-black spots. Prothoracic segment a little swollen; the shield not striped like the rest of the body. Body with narrow alternating light and dark green stripes; brown along the back, and inclosing a large round green spot on each segment; the brown portion with three interrupted green lines, one median and two lateral. Piliferous dots minute, not conspicuous. Length, 15mm.

Pupa.—Of the usual Phycid shape; mahogany-brown; end of the terminal abdominal spine smooth, shining, convex, and ending in a stout curved lateral spine on each side. Length 10mm.

Moth.—Body and fore wings dark gray, with brick-red scales and bands. Palpi very broad, especially the second joint; dark gray; vertex of head light gray, with dark scales; antennæ blackish. Prothoracic scales and shoulder tippets (patagia) dull brick-red; middle (disk) of thorax gray. Fore wings dark, dusky gray, with scattered pale gray scales; base of wings dull brick-red; a broad, diffuse band of the same color crosses the basal fourth of the wing; on the outer fourth of the wings is a similar broad, diffuse, dull brick-red band, sending a diffuse longitudinal stripe towards the basal band; an incomplete transverse pale gray line, curved outward in the middle of the wing, borders the inside of the outer reddish band. Costal edge dusky, the reddish bands not reaching it. Fringe of the same dull slate-color as the hind wings. Expanse of wings, 20mm. (Identified by Prof. C. H. Fernald.)

THE ALDER FLEA-BEETLE.

(*Haltica alni* Harris.)

In the correspondence of the late Dr. Harris the following mention is made of this beetle: "In traveling from Centre Harbor, N. H., to Conway, on the 2d of August, 1854, and from Conway to Upper Bartlett, and subsequently to Jackson, we saw the Alders (*Alnus serrulata*) everywhere ravaged by insects which had destroyed their leaves in the manner of canker worms. Upon examination the spoilers were found not to be all dispersed and several were seen upon the leaves still continuing their work; at the same time were found in Conway numerous beetles, which proved to be a species of Haltica, eating the leaves off the same Alders. The larvæ which had ravaged the shrubs were doubtless those of the Haltica before named."

We have reared the beetles from the grubs during the past season. At Merepoint, near Brunswick, Me., during the middle of August, 1886, we noticed clumps of Alders standing in dry soil partly defoliated or with skeletonized, brown or blackish leaves, on which, as well as the still remaining green leaves, were black grubs, sometimes seven or eight on a leaf. All the alders in the region were not molested, the grubs occurring locally. August 15 we found a single beetle, on placing a number of leaves with the grubs in a tin box. We found a white pupa lying loosely on the bottom of the box August 20; soon more pupæ appeared, and the beetles began to appear in considerable numbers the last week of August. It is evident that in nature the larva falls to the ground to transform, the pupæ entering the earth.

Afterwards, September 10, we found whole clumps of Alders at the base of Iron Mountain, Jackson, N. H., stripped by the grubs, nearly all the riddled, brown, dead leaves having fallen off and thickly covering the ground under the bushes. Such a wholesale devastation of Alders we never witnessed. By this time the beetles had become very abundant, and were apparently feeding on the few leaves still attached to the tree. The Alder is the source of some of our destructive forest and fruit insects, and should this grub ever spread to other food trees it will be very annoying, though it can be subdued by proper spraying. There seems to be a periodicity in the appearance of this beetle in unusual numbers, Harris having seen the same grubs in great abundance in 1854 in the same region. We have never observed it so common and destructive before in Maine. It is most probable that the beetles hibernate under the leaves and, soon after the leaves expand in May, lay their eggs in masses on them, the grubs scarcely stirring from the leaf on which they are born, until ready to pupate. The grubs are probably distasteful to birds, otherwise they would fall an easy prey to them and be kept within due limits.

DESCRIPTIVE.—*Larva.*—Body somewhat flattened; head scarcely two-thirds as wide as the body in the middle; black, becoming brown in front near the jaws. Body livid brown above; the tubercles black; paler beneath; with three pairs of

black jointed thoracic legs; no abdominal legs, but an anal prop-leg. The abdominal segments each with a traverse, oval-rounded, ventral, rough space forming a series of creeping tubercles; and in front on each segment is a transverse, oval, crescentic chitinous area bearing two piliferous tubercles; the back of each segment divided into two ridges, each bearing a row of six sharp tubercles, bearing short hairs; a single ventral row on each side of the ventral plate. Length, 7–10^{mm}.

Pupa.—Body rather thick, white. Antennæ passing around the bent knees (femerotibial joints) of the first and second pair of legs, the end scarcely going beyond the middle of the body. Elytra with five or six rather deep longitudinal creases. The salient points of the body armed with piliferous warts. Abdominal tip square at the end, with a stout black spine projecting from each side. Length, 6^{mm}.

Beetle.—Uniformly deep prussian blue, with greenish reflections on the head. Antennal flagellum with fine whitish pubescence; tibiæ clothed with tawny hairs. Length, 5–6^{mm}.

THE ALDER LEAF-ROLLER.

(*Gelechia oronella* Walsingham.)

While the leaves of the Alder are variously folded and rolled, perhaps the most striking leaf-roller is the above species, which occurred in Maine late in the summer, in August and the early part of September.

The little worm is amber-colored, the body rather thick and cylindrical, but with no distinctive markings. One was observed which had sewed a portion of the edge of the leaf for half an inch in extent with four or five large white silk stitches. The moth, which appeared in the breeding cage May 4 of the following year, is described below.

In another example, probably of this species, the end of the leaf was rolled up one and a half turns, and sewed with three broad strong silk stitches. On unrolling it the end of the leaf was found to be more or less eaten, the roll being gradually drawn in and made more perfect as the caterpillar consumes the tip of the leaf. It pupated September 18.

DESCRIPTIVE.—*Larva.*—Body rather thick, cylindrical; body and head delicate amber-colored; end of the body with quite long hairs, longer than the body is wide. Length 6^{mm}.

Pupa.—Rather thick; mahogany-brown; length, 7^{mm}.

Moth.—Palpi with the second joint moderately broad, scarcely more than twice as wide as the third joint, which is moderately broad and two-thirds as long as the second joint. Head and palpi whitish-gray; second joint black externally; third joint white, with two black rings. Fore wings of the usual shape; white-gray; at the base a black streak parallel to the costa; on the basal fourth of the wing is a pair of converging black spots; beyond is a similar but thicker pair of black spots, and still beyond another pair, one of the spots being situated on the costa; four black costal spots towards the apex of the wing. Hind wings pale glistening gray. Expanse of wings, 18^{mm}. I am indebted to Professor Fernald for the identification of this species.

THE PINK-STRIPED WILLOW SPAN-WORM.

(*Deilinia variolaria* Guen.)

The caterpillar of this pretty moth is one of the commonest inch worms to be found on the Willow.

The genus to which this caterpillar belongs was founded by Huebner for a moth referred by Guenée to *Cabera*. The species of Deilinia are

distinguished from those of *Corycia* by the pectinated antennæ, the two common lines, and the generally ocherous tint, though the females of *D. variolaria* are with difficulty separated from those of *Corycia*. From *Acidalia* the species differ in having pectinated antennæ, in the want of a decided band on the hind wing, and in the larger palpi. The species is figured on Pl. 10, fig. 26, of Packard's Monograph of Geometrid Moths.

The caterpillar occurred August 10 on the Willow at Brunswick, Me. It pupated August 14, and the moth emerged from May 20 till June 6. The moths are seen flying among willows in June and July. We have also found the larvæ July 24, and from that date till the first week in September.

DESCRIPTIVE.—*Larva.*—Body smooth, cylindrical. Head as wide as the body, flattened from above, especially in front; antennæ pinkish. Green with a pinkish tinge; on the side of the head a lateral distinct deep pink line, sutures and upper side of the segments pinkish. There are eight dorsal median spots along the abdominal segments, a central dark-brown dot, flanked on each side by a pale lilac patch. First pair of abdominal feet deep lilac; anal legs with a vertical anterior lilac line. Supra-anal plate large, triangular, with two minute tubercles. Length, 22^{mm}.

Pupa.—Thorax moderately stout, at first greenish, finally becoming like the abdomen, mahogany-brown; terminal spine (cremaster) rather stout and blunt, ending suddenly in two large curved bristles with three minute slender much curved ones on each side; the basal pair situated about half-way between the base and the middle of the spine. Length, 10^{mm}.

Moth.—Front of head deep reddish-ocherous; white on the front edge; palpi deep ocherous; antennæ white. Fore wings with the costal edge rather full. Both wings strigated more or less thickly with brown; sometimes the wings are pure white. In the male, the strigæ (or short lines) are arranged in two parallel lines on both wings. Beneath, pure white; sometimes a complete black discal dot on each wing. Fore and middle legs ocherous. Expanse of wings 26^{mm}. This species differs from *D. erythemaria* (Guen.), also common in the Atlantic States, by its white wings, which are often without lines, and by the deep reddish ocherous front of the head.

THE HERALD.

(*Scoliopteryx libatrix* Linn.)

This fine moth, common to the New and Old World, is in England called "the Herald." Here as well as in Europe it feeds as a general rule upon the Willow, but we are told by Mr. H. L. Clark that he has bred it from the Wild Cherry in Rhode Island.

Its habits so far as they have noticed are nearly the same as observed in Europe. Mr. Lintner, the State Entomologist of New York, says that the caterpillar feeds on and pupates among some of the leaves drawn together by silken threads to which the pupa is attached by an anal spine. The fall brood remains in the pupa state from fifteen to twenty days. He bred a moth which emerged August 3, hence he thinks that there are probably two annual broods of this species, since he has taken it in the early part of May. In Illinois Mr. Coquillett bred a larva which spun its cocoon August 23, while the moth appeared September 7.

Professor Riley's notes show that he found the larvæ at Kirkwood, Mo., in May, 1872; that they began to spin their cocoons May 29; and that the moths began to emerge June 11. On June 17 eggs were found.

We have found the larva on the Willow at Brunswick, Me., August 26, when it was nearly fully grown. It is easily recognized, since it is one of the few Noctuid caterpillars to be found on the Willow, and may be recognized by its pale green hue and the yellow lateral line as well as the yellowish sutures between the body-segments. A chrysalis beaten out of a Willow tree during the last week in August disclosed the moth about the 12th of September. Another chrysalis was found at Jackson, N. H., during the second week in September, the moth appearing September 14. The larva had sewed together four or five willow leaves at the end of a terminal shoot, and the cavity thus formed was lined with a thin but dense whitish cocoon in which the pupa was situated with the head upwards, and firmly held in place by the hooks on the abdominal spine. The moth hibernates, appearing in May as soon as the leaves are unfolded, and we see no grounds for supposing that there is more than a single brood of caterpillars or of moths. The chrysalis is quite unlike that of most Noctuidæ which transform in the earth, and has a simple blunt spine. The cremaster or spine of the present species is much like that of those Geometrids which spin a cocoon.

We thus have an interesting departure from the usual structure and habits of a numerous family of moths, the end of the pupa being specially adapted for a residence in a cocoon to prevent its being shaken out of its exposed pupal abode. Like all tree-feeding Noctuidæ, the caterpillar is well protected from observation by its style of coloration; in the present case the pale green assimilating it to the leaves among which it feeds.

THE BROWN CRYPTOLECHIA.

(*Cryptolechia quercicella* Clemens.)

The leaves of the Oak and, as we have found the past season, the Aspen, are often bound together by a rather large flattened Tineid caterpillar, larger in size than most larvæ of the family to which it belongs. It is of about the size of the caterpillar of another less common species of the same genus (*C. schlagenella*) whose habits we have already described in Bulletin No. 3 of the Division of Entomology (U. S. Department Agriculture, p. 25.)

The larva of the present species (originally described by Clemens as *Psilocorsis quercicella*) was said by that author* to bind the leaves of oaks together in August and September (in Pennsylvania) and to pick out the parenchyma between the network of veins; to weave a slight cocoon between two leaves, appearing as a moth in March and April. Our observations confirm the accuracy of Clemens's observations. In

*Proc. Acad. Nat. Sciences, Phil., June, 1860. See also Clemens's Tineina of North America, edited by H. T. Stainton, p. 149.

1884 we reared it from the Oak in Providence, the moths in confinement appearing May 3 to 13 of the following spring.

During the season of 1886 we found the larvæ both on the Oak and on the Aspen at Brunswick, Me., during the last week in August (the 25th to 31st). It disfigures these trees by binding the leaves together, where it occupies a gallery in the mass of excrement filling the space. It weaves a slight, but quite consistent, oval, flat cocoon between the somewhat crumpled leaves; the moths appeared in the breeding cages from May 15 to 20; at first sight the moth resembles a Tortrix, the wings being wide and broad at the end, and the markings plain; it is very different in appearance from the moth of the other species we have mentioned, which is white, with longer, narrower wings. The abdominal spine of the chrysalis is also very peculiar in shape.

DESCRIPTIVE.—*Larva.*—Body flattened. Head wide, slightly narrower than the prothoracic segment; dark brown; prothoracic shield dark brown, slightly paler than the head. Body behind pale livid greenish flesh-colored; no dorsal setiferous warts, but on each side of each segment are two dark warts of unequal size giving rise to long hairs; below them are two smaller, paler, less conspicuous warts. Supra-anal plate large, broad, rounded, blackish, with five setiferous warts around the edges of the plate. All the legs concolorous with the body. Length, 12^{mm}.

Pupa.—Of the shape of the Tortricidæ, being unusually stout and of a mahogany brown color. Abdominal segments peculiar in having a single, finely crenulated ridge passing dorsally and laterally around the front edge of the segment; there are no teeth or spines, but a rough surface on the ridge with confluent granulations The tip is peculiar, the last segment being conical, with a stout spine (cremaster), which is rounded, a little flattened, and ending in two forks, from the sides and ends of which arise in all 6–8 long bristles, which stick into the silken lining of the rather slight cocoon in which it transforms. Length, 7^{mm}.

Moth.—Recognized by its large size, broad square wings, and long slender palpi, curving backwards high over the head. Head, thorax, and fore wings tawny gray, with a line of fine dark scales on the base of the antennae and on the upper and under side of the last joint of the palpi. Fore wings uniform tawny gray, mottled with fine blackish scales; no distinct markings except a dark diffuse discal dot. Fringe gray. Hind wings and abdomen as well as the legs shining pale tawny gray, much lighter than the fore wings; beneath of the same color, except that the fore wings are somewhat dusky except on the outer edge and outer half of the costal margin. Expanse of wings 20^{mm}.

THE BEECH SPAN-WORM.

(*Hyperetis nyssaria* Smith and Abbot.)

Although the Alder is one of the food trees of this not uncommon inch-worm, it is known to live on the Beech. The specimen reared from the Alder by us is described below.

I have reared this moth from a large span-worm found on the Alder September 6, at Brunswick Me., which exactly resembled a small twig of the same shrub. It pupated September 20, in a broad flattened oval cocoon spun between the leaves, and the moth appeared at Providence in the breeding cage May 15 of the following year.

Mr. W. Saunders has reared the moth from a caterpillar found on the Beech, and it will probably occur on other trees.

Larva.—Head rather small, much narrower than the body, somewhat flattened in front. First thoracic considerably narrower than the second thoracic segment; second and third thoracic segments with lateral slight swellings; the black spiracles are situated on dusky swellings; on the fifth abdominal segment is a dusky dorsal hump, edged in front with white, consisting of two rounded conical tubercles. Supra-anal plate rounded with two stiff terminal setae; anal legs rather broad, with a setiferous fleshy conical tubercle on the upper edge. General color of head and body lilac-brown; head slightly more reddish, and on the back of each segment is a pair of whitish spots, especially distinct on the second thoracic, but wanting on the first segment. Supra-anal plate and anal legs sea-green, mottled with dusky spots. Length 28^{mm}.

Pupa.—Body rather thick; mahogany-brown, ends of wings and legs reaching to the posterior edge of the third abdominal segment. Terminal spine of the abdomen (cremaster) large, flattened beneath, broad, triangular; the upper and under surface with fine irregular wavy longitudinal ridges. Four lateral curved bristles and a terminal pair about twice as thick and long as the others. On the under side at the base of the spine are two orbicular areas like flattened tubercles. Length 12 ^{mm}.

Moth.—Fore wings pale whitish, with fine cross specks as usual; the basal cross line is heavy on the costa and bent sharply outwards on the subcostal, with a smaller angle on the median vein and a larger angle on the submedian vein. The great but obtuse angle made by the outer line extends quite near the outer edge of the wing. Half way between the apex and the outer line two brown costal patches; two unequal black patches near the internal angle. Beneath, the lines and cross specks are reddish-brown. Expanse of wings 33^{mm}. The specimen does not agree with either of the four figures in my Monograph of Geometrid Moths, differing especially in the shape and direction of the outer line.

THE CLEFT-HEADED SPAN-WORM.

(*Amphydasis cognataria* Guen.)

This common inch or measuring worm is the largest species we have met with feeding on the Willow, and may be readily recognized by its deeply cleft head and reddish-brown or green body like a reddish or green willow twig, which it closely mimics. We have noticed it as frequently in Jackson, N. H., as in Maine. It becomes fully fed by the first week in September, my specimens transforming September 8, the chrysalis entering the earth. The moth appears in June in Maine, late in May in Southern New England and New York. I have raised this moth in Maine from the Larch (pupating September 15), also from the Missouri Currant, an ornamental shrub; also from the Apple, Elm, Cherry, and the Aspen in Rhode Island, though the Willow is probably its native food-plant, as it occurs in greatest abundance on that tree. Mr. Lintner states that the larva feeds on the Maple; that the caterpillar entered the ground for pupation August 11, the moth emerging the latter part of May. (Ent. Contr. III, 166.) My specimens emerged in Providence, May 13. The larva found on the Aspen is greenish and like a fresh aspen twig, with whitish granulations, which are black on the tubercles.

DESCRIPTIVE.—*Young larva.*—Head large, deeply notched, each tubercle distinctly conical; body cylindrical, slender, with no tubercles; a little smaller in the middle than at each end. Head and body uniformly of a dull, brick-red. Length 13 to 14mm.

Larva before the last molt.—With the characters of the adult larva; salmon red. Length 35mm.

Mature larva.—Twig-like, head very deeply notched, each side above conical; the face flat in front, the surface granulated. Prothoracic segment raised in front into a large granulated piliferous tubercle. On the fifth abdominal segment a pair of large lateral rough tubercles, a little paler than the body; on the 8th segment a pair of converging pale granulated tubercles. Anal legs very large and broad, with a pair of long dorsal sharp fleshy tubercles; supra-anal plate very large, conical and acute, with four setae near the apex. Body of even width throughout, reddish-brown, like a reddish willow twig, or sometimes greenish. The surface finely granulated with light and black, and with flat rough warts, paler in color than the rest of the body; four on the front edge of each segment, and two dorsal ones behind. It varies in color from reddish-brown to green, thus mimicing willow twigs of different colors. Length 55mm.

Pupa.—Large, full, stout; dark brown. Cremaster large, stout, a projection on each side in the middle, beyond rounded, sharp, the point ending in a slender fork. Length 24mm.

Moth.—A large stout-bodied moth, with heavily pectinated antennæ and rather small wings. Fore wings narrow, with the outer edge longer than usual; pepper and salt or ash sprinkled with black brown; an indistinct, diffuse, inner, curved line, with a second one nearer and diverging a little on the costa, being nearer together at the base. A third diffuse line encloses the discal spot. An outer distinct black hair-line always present. Hind wings with three dark lines. Abdomen with two rows of obscure black spots. Expanse of wings 60mm.

ICHTHYURA STRIGOSA Grote.

The caterpillar of this interesting species was found July 30, at Brunswick, Me., feeding on the Aspen (*Populus tremuloides*). It moulted August 10, and about the 20th began to spin a silken cocoon between two leaves. The moth (a male) appeared in the breeding cage at Providence, May 20. Like *I. americana*, it sits with the wings folded sharply over the back, with the fore legs held straight out in front, with the tufted tail curved up.

DESCRIPTIVE.—*Larva before the last molt.*—Head broader than the body, flattened in front, dull black, with long white hairs. Body flattened, with yellow and reddish longitudinal stripes; three dorsal faint red stripes on a yellowish ground, and three deep lake-red lateral stripes, the lowermost the broadest and deepest in hue. Two bright yellow lateral stripes. Five pairs of flesh-colored abdominal legs, the legs pale amber, colored like the under side of the body. Length 9mm.

Larva after the last molt.—Markings much as in the previous stage. Length 17 to 18mm.

The rude cocoon is formed by tying a few leaves together, gathering them by a web at the edges, thus forming a roomy chamber, partly lined with silk, within which the chrysalis rests.

Pupa.—Smaller and not so full and rounded at the end as in *I. inclusa;* cremaster as in that species, ending in two stout, very short, recurved spines. Length 12mm.

Moth.—One male. Smaller and duller brown than *I. indentata* Pack. Palpi whitish below, dark-brown above, as in *I. indentata* (which closely resembles Fitch's *I. vau*); front of head slightly broader and squarer; median thoracic brown band as in

I. indentata. Fore wings with the costal edge straighter and the apex less turned up than in *I. indentata*, the apex being slightly more rounded than in that species or in *I. inclusa.* Basal line distinct, making a sharp angle on the median vein, and more incurved in the submedian space than in *I. indentata;* second line much more suddenly incurved than *I. indentata*, the same line being straight in *I. inclusa ;* the short third line as in *I. indentata*, but more sinuous. Fourth and outer line much as in *I. indentata*, but the species differs from all the others known by the large conspicuous irregular whitish ochreous patch which fills in the costal curve of this line and extends half way from the costal end of the line to the apex of the wing; no deep brick-red discoloration on each side of costal half of fourth line, so distinct in *I indentata*, but a long discal blackish stripe extends along the first median venule to the submarginal row of brown dots which are not so distinct as in *I. indentata* or *I. inclusa ;* though the marginal row of dark brown lunules is as distinct as in *I. inclusa.* Fringe as in *I. inclusa*, but that on the hind wings much darker. Hind wings darker than in *I. indentata.* Wings beneath much as in *I. indentata*, but there is no reddish tint towards the apex, and the white oblique costal streak is much less distinct. There are traces of a common brown diffuse line. Abdomen a little shorter, the fan or tuft of scales perhaps shorter and expanding wider. Expanse of wings 25^{mm}.; length of body 12^{mm}.

THE LIVE OAK THECLA.

(*Thecla favonius* Smith and Abbot.)

The green, slug-like caterpillars of this beautiful butterfly were observed on the Live Oak at Enterprise, Fla., April 7 and 8, also a few days afterwards at Crescent City, and again on the Scrub Live Oaks on Anastasia Island, Saint Augustine. They pupated April 13, 14; the chrysalis in general appearance closely resembling that of *Thecla calanus*, found about Providence. They breed easily in confinement, my specimens having been placed in a small pocket tin box. After my return to Providence the butterflies emerged from April 30 to May 2. It is the most common species in the Southern States, and is said by Smith and Abbot to feed on *Quercus rubra* and other Oaks.

DESCRIPTIVE.—*Larva.*—Closely resembling in general appearance that of *Thecla calanus.* Body straw-yellowish green, with fine yellowish papillæ and dense short hairs. Head pale horn-color, small and narrow. Length 17^{mm}.

Pupa.—Of the same size and shape as that of *Thecla calanus*, the hirsutes the same, though not quite so coarse. In color rather pale horn, not so much mottled with black. It differs from *T. calanus* in the distinct lateral row of black dots. Length 10^{mm}.

Imago.—Wings of the usual form and color in the genus. Fore wings of male with a blackish sex-mark below the costa; a tawny patch in the first and a larger more distinct one in the second median cell. Hind wings with a large deep orange patch near the inner angle, with a minute one on each side; orange spots on the inner angle. "The points of the W formed by the inner line on the under side of the hind wings touching the outer line" (French). Expanse of wings, 23^{mm}.

THE LIVE OAK LEAF-ROLLER.

Tortrix quercifoliana Fitch.

While at Saint Augustine, Fla., early in April I noticed a pale green leaf-roller on the Live Oaks on Anastasia Island. April 14 it spun a

slight cocoon, within which the worm changed to a pupa, April 16 or 17; the moth appeared April 30, after my return to Providence.

DESCRIPTIVE.—*Larva.*—Pale green; head green; otherwise of the usual appearance.

Pupa.—Body pale and slender, the cast skin thin and unusually so for a Tortrix. Cremaster or terminal abdominal spine peculiar in being long and narrow, as wide at the tip as at the base; the surface above and beneath with fine longitudinal ridges; a pair of short dorsal setæ near the end; edge of the extreme tip curvilinear, with four curved setæ of nearly equal length. Each abdominal segment with two rows of fine teeth. Length, 10^{mm}.

Moth.—Pale tawny yellow, with yellowish brown darker scales and dots and darker brown lines. Head pale, tawny brown on the vertex with a small spot in the middle of the front. Palpi dark, externally pale above and at tip of second joint. Fore wings pale whitish tawny yellow, densely speckled with darker scales; on the inner third of the wing an oblique, dark brown, narrow line beginning on the inner third of the costa and ending in the middle of the hind margin. An outer parallel line, which is forked on the costa and ends on the internal angle; from near the middle the line sends off a spur to the apex, but before reaching the apex a spur is sent to the costa, also a 3-forked line to the outer edge of the wing. Hind wings, abdomen, and legs almost white. Expanse of wings, 20^{mm}. (Identified by Prof. Fernald.)

REPORT ON NEBRASKA INSECTS.

By LAWRENCE BRUNER, *Special Agent.*

This has been an unusually favorable year in Nebraska and adjoining States for the ravages of certain injurious insects. The spring was a little backward, rather drier than usual, and warm, suitable for the development of all kinds of our most destructive species. The summer was a hot and uncommonly dry one, killing off the parasites, while continuing favorable to most of the species causing injury to crops.

Among the species noticed to be injurious the following were chief: The Red-legged Locust (*Melanoplus femur-rubrum*), the Differential Locust (*M. differentialis*), Chinch Bug (*Micropus leucopterus*), the Striped Cottonwood Beetle (*Plagiodera scripta*), the Ash Saw-fly, the Colorado Potato Beetle (*Doryphora 10-lineata*), the Gray Blister Beetle (*Lytta cinereus*), the Corn Worm (*Heliothis armigera*), and the larvæ of the Ash Saw-fly, and early in the season the Box-elder Plant Louse.

Notwithstanding the ravages of all these insects in connection with a very dry summer, our crops have fallen but little below the average year, and at the present time everything appears in first rate condition.

As would naturally be supposed, from data received last year, locusts are again on the increase at various points both southward and northward. During the months of April and May I visited, under your instructions, central Texas, where several species of these insects had become so numerous as to endanger the crops in that particular locality. Upon these I reported at the time. We have since learned that crop prospects in that portion of the State were good, and that the locusts were diminishing in numbers. On the other hand, in Montana and northwestern Dakota, advices stated that the Rocky Mountain Locust (*Melanoplus spretus*) with several other species, were even more numerous than they were in these places last year. This being a new and sparsely settled country it has been very difficult to obtain reliable data as to their numbers, movements, and injuries, if any.

Judging from occasional newspaper reports during the season it is quite evident to my mind that scattering swarms of locusts have reached eastward at least as far as the James River, along the line of the Northern Pacific Railway, and southward of this point probably 75 or 100 miles. These swarms have certainly left their eggs scattered over the country passed through while migrating, and will evidently be heard

from next spring, providing the winter is favorable to their preservation. We do not, however, look for any extraordinary increase in these insects over an extended scope of country next year.

In southwestern Nebraska and portions of northern Kansas the Chinch Bug (*M. leucopterus*) became very numerous during June and early July, and did a considerable amount of injury to crops—especially to small grain. This undue increase was mainly due to the excessive drought in that particular region. A reference to the accompanying telegraphic crop reports will be sufficient proof of the magnitude of the injury done and the area overrun. Soon after harvest heavy rains in this region diminished the numbers of the insect.

The Striped Cottonwood Beetle (*Plagiodera scripta*) has also been quite numerous in several portions of the West during the year, and did much injury to both Cottonwoods and Willows upon high land. Especially was this true with respect to the young trees upon tree claims in newly settled areas. There has been considerable vexation at the United States land offices on account of the injuries of this insect and of a species of Saw-fly, the larvæ of which attack the foliage of our various species of Ash trees, causing them to die. When the time comes for "proving up" there are too few trees growing upon the tract of land, and the result is its probable loss to the enterer.

The Colorado Potato Beetle (*Doryphora* 10–*lineata*) and Cabbage Butterfly (*Pieris rapae*) have both been rather more abundant than usual during the year and have done much injury to their respective food-plants.

In addition to these, the Ash-gray Blister Beetle (*Lytta cinerea*) has been observed in several localities in northern Nebraska to entirely defoliate young hedges of Honey Locust. Until the present summer I have not observed this insect attacking the Honey Locust since the summer of 1876 or 1877. At that time a nursery of small trees of this kind were entirely stripped of leaves by them, as were also several larger ones standing alone.

The Corn Worm (*Heliothis armigera*) was very numerous and caused considerable injury by eating the ends of the ears of corn. It has also been found quite abundant in tomato patches, where it bored into the fruit, causing the tomatoes to rot.

We append a series of short extracts from western newspapers bearing on some of these topics.

"GRASSHOPPERS."

A cloud of grasshoppers stopped for a meal at Sanborn [Dakota] recently and chewed up a field of wheat in ten minutes.—*Omaha Daily Bee*, July 23, 1866.

Grasshoppers are reported in numerous quantities in Winneshiek County, Iowa, Howard County, Indiana, and in Athens County, Ohio.—*Omaha Daily Bee*, May 31, 1886.

Grasshoppers are reported at Fargo and Huron, Dak. Lawrence Bruner, who is authority on the subject, informs us that there is no doubt they are increasing yearly,

and unless something is done to check them they will eventually be as numerous as ever. One consolation, however, is that they will never be able to do the same amount of damage in one locality as formerly, on account of the wider expanse of settled and cultivated land over which they will have to travel. Nebraska is forever more free from any serions ravages.—*West Point Progress*, Thursday, July 22, 1866.

CHINCH BUGS.

CHICAGO, *May* 30.—The following crop summary will be printed in this week's issue of the *Farmer's Review*: "As the season advances reports of the presence of insects in winter wheat fields grow more numerous, but beyond certain afflicted districts in Kansas, Illinois, Indiana, and Ohio the reports are of an isolated character and do not appear to seriously threaten the general outlook for an average crop yield. Southern Illinois continues to send in the most bugs. Alexander, Bond, Edwards, Jefferson, and Monroe Counties, all in Southern Illinois, report great injury in many of the fields. Grenola, Franklin, and Panorama Counties, in Kansas; Felton and Highland Counties, in Ohio, and Howard County, in Indiana, report considerable injury from chinch bugs. Looking over the entire winter wheat belt, the promise is still good for an average yield, but the early promise that the season was to bring forth a "bumper" crop will now be abandoned. The acreage would not warrant such an outcome, unless the conditions were everywhere extremely favorable.—*Omaha Daily Bee*, May 31, 1886.

CHESTER, NEBR., *July* 2.—[Special to *The Bee*]—The chinch bugs have been making great havoc with the spring wheat. Some fields are entirely destroyed, others greatly damaged, and scarcely any left untouched. When the bugs get through with the wheat they attack adjoining cornfields and are damaging them to some extent.

BELVIDERE, NEBR., *July* 2.—[Special to *The Bee*]—Prospects for all kinds of crops are good with the exception of wheat, which the chinch bugs are taking to some extent.

HEBRON, NEBR., *July* 2.—[Special to *The Bee.*]—Crops have needed rain badly for some time until last Saturday, when a copius downpour came to their relief. Wheat is suffering from the depredations of chinch bugs, many fields having been taken entirely and not considered worth harvesting. Corn is growing finely, and although small for the season of the year bids fair to make a good crop.—*Omaha Daily Bee*, July 3, 1886.

HASTINGS, ADAMS COUNTY, NEBRASKA, *July* 9.—Rye and barley harvest is showing about two-thirds of a crop. The yield of oats and wheat, on account of drought last month and the present ravages of chinch bugs, will not exceed two-fifths of an average yield. Corn is doing fairly well but needs rain.

CRETE, SALINE COUNTY, NEBRASKA, *July* 9.—The condition of wheat is bad. Chinch bugs and rust are the cause, and there will be only a half a crop. Oats will only be half a crop, on account of late planting. Barley will be a larger crop than last year. Rye is a heavy crop There has been no rain for ten days. Farmers are jubilant.

WAHOO, [SAUNDERS COUNTY,] NEBR., *July* 9.—Nearly all the corn is laid by. It is needing rain badly. A few more days of dry weather will work great injury, but a rain in a few days will help it wonderfully. Oats and spring wheat will be slightly injured by drought, and chinch bugs are doing some damage to wheat.

EXETER, FILMORE COUNTY, NEBRASKA, *July* 9.—Wheat will be a poor yield this year. Chinch bugs are reported from several places as very destructive. Corn was never better. It is two weeks since the last rain and more is needed, but no damage as yet. Farmers feeling o. k.

FAIRMONT, FILLMORE COUNTY, NEBRASKA, *July* 9.—Farmers need rain very much. Wheat, small acreage, is badly eaten by chinch bugs and injured by drought and heat. Corn and other small grains are suffering from drougth and heat. If dry spell continues one week more, farmers will raise only a small crop.

DANNEBROG, HOWARD COUNTY, NEBRASKA, *July* 9.—The hottest day so far this summer was yesterday, the temperature reaching 104° in the shade. No rain has fallen

for five weeks and growing crops are suffering. Some fields of oats and spring wheat will be an almost total failure. Rye, winter wheat, and barley are ready for harvest, and the yield will be fair; chinch bugs are commencing to be very bad in some parts of the county. The prospect of a good corn crop heretofore has been good, but now it is discouraging on account of the drought.—*Omaha Daily Bee*, Saturday, July 10, 1886.

HEBRON, THAYER COUNTY, NEBRASKA, *July* 10.—Corn is in need of rain. The dry weather has continued for a period of two weeks or more. Small grain in general is suffering for want of rain. A rain any time within a week will help the corn in its growth and destroy the chinch bug, now playing havoc in many fields. Most of the small grain failed to fill out by reason of the dry weather, and its production won't reach that of last year's by one-half. Our farmer friends are somewhat discouraged over the present outlook for prospects of a good corn crop.

YORK, YORK COUNTY, NEBRASKA, *July* 10.—Chinch bugs are working on wheat and other small grain. Corn looks fair, but some of it is turning to a yellowish shade. Squash and melon vines are wilting and bugs working on them. No rain for nearly three weeks. If we have rain in a few days there will not be a great shortage on an average crop. Farmers feel blue, knowing that the crop will not be an average one.

YORK, YORK COUNTY, NEBRASKA, *July* 10.—The condition of the corn crop in York County is good, notwithstanding the dry weather of the past two weeks. Oats will be an immense crop. Spring wheat is an entire failure. The crop was very short and what remained is being rapidly destroyed by the chinch bugs. The dry weather has had a damaging effect on wheat and corn. Winter wheat and other crops are good. The York County crop will average about 60 per cent.

EDGAR, CLAY COUNTY, *July* 10.—Small grain has suffered badly from the drought in this part of Nebraska. There has been no rain in this section for two weeks, during which time the weather has been intensely hot and dry. Barley and rye are harvested, but there is not more than two-thirds of a crop. There was yielded about two-thirds of a crop. Spring wheat and oats are very short, and are being destroyed by chinch bugs rapidly. Unless rain comes soon, but little grain will be harvested on account of chinch bugs. Farmers are very much discouraged, though they still entertain hopes of a medium corn crop.

FAIRCHILD, CLAY COUNTY, NEBRASKA, *July* 10.—Wheat will make about one-half a crop, barley about three-fourths, and oats a good average yield. Dry weather in the early part of the season injured small grain most. We had good rains in the latter part of May. Since that time it has been dry, no rain at all since June 28. Corn is looking well in spite of dry weather. If we get rain in a few days there will be a good prospect of nearly a full crop. Lately chinch bugs have made their appearance in large numbers and are doing considerable damage. Farmers, as a rule, are feeling in good spirits over the crop prospects.—*Omaha Daily Bee*, July 12, 1886.

FORT DODGE, IOWA, *July* 16.—[Special telegram to *The Bee*]—A much needed rain fell in this locality yesterday. * * * The crops are slightly damaged by the drought. Chinch bugs have made their appearance in portions of the county and are getting their work in on grain and corn.

HEBRON, *July* 16.—[Special to *The Bee*]—Your correspondent has made a thorough investigation of crops in Thayer County and Southern Fillmore, arriving at this place to-day. The chinch bugs have entirely destroyed many fields of spring wheat and oats. Some fields have been burned on the ground, with the hope of killing the bugs to keep them out of adjoining fields of small grain and corn. At the best, small grain will not make over one-third of a crop throughout this section. Corn has looked well until within the past ten days, but the hot, dry weather of the last two weeks has put a different hue on the aspect and on farmers' countenances. The earliest plantings and most forward corn suffers the most, but on all sides can be seen, sprinkled through the fields, stalks of corn that are white as snow. With copious rains within a few days a fair crop of corn may be had, but a delay of wet weather for ten days

will insure anywhere from one-third of a crop to nothing. Pasture and hay lands are also showing the effects of the drought.—*Omaha Daily Bee*, July 17, 1886.

GRAND ISLAND, HALL COUNTY, *August* 5.—The wheat crop throughout Hall County is turning out much better than was expected. In some precincts the farmers report the yield better than it has been for years, while in other localities it was damaged by drought and chinch bugs, but the average yield will be about 12 bushels per acre. The recent rains have done much toward bringing out the corn crop, which is in a splendid condition, and in some places it will make 60 to 80 bushels to the acre, and without any more rain it will average about 40 to 50 bushels to the acre. Farmers are feeling good generally, and think the entire crop, on an average, is better than it has been for years.—*Omaha Daily Bee*, August 6, 1886.

TESTS WITH INSECTICIDES UPON GARDEN INSECTS.

By WILLIAM B. ALWOOD, *Special Agent.*

LETTER OF TRANSMITTAL.

COLUMBUS, OHIO, *October* 30, 1886.

SIR: I inclose herewith a summary of my tests with different insecticides. These are not written in the style of a report, but to acquaint you with the results I have obtained. My work is just begun, and I do not feel as though anything creditable in the way of a report could be furnished so far. I trust this will be satisfactory and furnish you with what information you desire concerning the progress of the work thus far. If you desire it I can furnish a copy of the original notes from which this summary is made up; however, many of my serial tests were noted in bulk instead of keeping an individual record of each test. This was done because of sameness and lack of importance in the individual record. This matter would have reached you a week sooner had I not been ill for several days. I will forward some notes about machinery in a few days.

Very respectfully,

WM. B. ALWOOD

Prof. C. V. RILEY,
U. S. Entomologist.

KEROSENE EMULSION.

Formula.—Kerosene, 67 per cent.; water, 33 per cent.; whale-oil soap sufficient to form a stable emulsion.

This preparation was used on several insects with somewhat varying results, the chief features of which are condensed in this note.

On Cabbage Worms.

The first series was begun before *Plusia brassicæ* was numerous, hence only *Pieris rapæ* is spoken of. The emulsion was used in different dilutions, ranging from equal parts of water and emulsion to 16 parts of water and 1 of emulsion. It was in all cases applied as a spray, and when the worms were numerous and eating vigorously. Several hundred plants were used in the field tests. Weaker solutions than 1 of emulsion to 3 of water were of no avail unless applied very heavily, and then they caused considerable injury to leaves. In the proportion of 1 to 3 it was quite effective where the worms could be reached, *i. e.*, were not under the leaves, and destroyed about 75 per cent. of them. It did not injure the leaves in this strength if properly sprayed. Where solution of 1 to 5 was put on excessively it killed and also injured plants. Stronger solutions than 1 to 3 were not more efficacious and injured plants seriously. The weaker solutions would sicken the worms and

affect them unpleasantly for a short time, but they would uniformly recover, and either proceed again to eat or crawl away to another plant. In no case were worms injured unless spray was delivered directly upon them. Eating of the plants after they had been sprayed did not affect them. These experiments occupied several days and were duplicated.

Tests in small Jars.—This was a duplicate test on *Plusia brassicæ* and *Pieris rapæ.* The liquid was applied with a feather and in sufficient quantity to moisten the entire body of the worm. In dilutions up to 1 to 5 it killed both; weaker solutions occasionally killed one or more *rapæ* but not *brassicæ.*

In breeding Cages.—In this test the above was duplicated on larger scale. Liquid was applied as spray and until all worms were thoroughly drenched. They were placed on parts of a small cabbage-head, so that each box very nearly represented an out-door experiment and enabled me to be much more certain of results obtained.

Up to 5 dilutions 80 per cent. of *rapæ* were destroyed and 10 per cent. of *brassicæ*, there not being much difference in the strength of liquid as to efficacy. Weaker solutions did little or no injury to either. *P. brassicæ* was not treated with emulsion at all in the field, but from effect on *rapæ* am sure that the conditions were essentially those of outside experiments. The amount of drenching with this liquid which *brassicæ* could stand was certainly remarkable. In previous test jars were covered. Liquid in each case was taken from same jar of emulsion. I had no trouble in making a good emulsion that was stable in whatever dilutions I chose to use it.

On Cabbage Plant-louse.

Wherever used on this insect, even in weakest solutions (1 to 16), the emulsion destroyed all that were touched by it.

On White Grubs.

A solution of 1 part emulsion to 4 parts water was used quite extensively on the larvæ of the May beetle, *Lachnosterna fusca.* The results were far from satisfactory. Where used on the lawn the grubs descended 2 or 3 inches and were unharmed. Some few appeared a little sick, and occasionally a black spot was observed on some of them, but none were destroyed. After conducting this test for twenty days it was abandoned. Several boxes were arranged with loose soil and grubs placed in these for experiment. Here where they were only lightly covered with loose soil the emulsion destroyed nearly every one in twenty-four hours. The liquid was sprinkled on in these tests sufficiently to moisten the surface thoroughly.

Lime and salt were also tried over the lawn and in boxes. On the lawn where they washed through, the grubs immediately descended out of reach. None were actually killed on the lawn that I could observe,

In boxes lime was nearly as efficacious as emulsion, and so also was salt; however, to do good execution, salt must be applied in quantity sufficient to injure the soil. I think there is no doubt but these insects can be easily destroyed if they can be reached, but how to reach them under the soil is the question. Their large, soft bodies are very susceptible to injury.

PYRETHRUM.

This powder was purchased from a local wholesale dealer, and to all appearances was of high grade. It was used in various tests to experiment on its use, and as a check on other substances it was used in all tests of whatever nature.

On Cabbage Worms.

My earlier experiments lead me to believe that *brassicæ* was much harder to destroy than *rapæ*, and this I still believe to be the case to some extent, but not to such an extent as at first supposed. Quite a large series of tests were made in the field and also in jars and cages to test the above supposition, the result in the main being very satisfactory. Pure and up to 3 dilutions it killed *rapæ* with a precision and certainty that was remarkable, the powder after the 3 dilutions acting nearly as well as if stronger. The time required was variable, but usually the worms were well used up in two hours. Above 3 dilutions its action was uncertain and not to be depended upon, although 5 dilutions will kill a fair percentage if thoroughly applied. With *brassicæ* the results were quite similar up to 3 dilutions. A large quantity of powder was used of this strength on these worms after *rapæ* had nearly disappeared. It was very effective, killing fully 90 per cent. of all worms, although the time required is somewhat longer than with *rapæ*. Above 3 dilutions it is not efficacious on *brassicæ*, killing scarcely any, and from the whole experience of my experiments I am satisfied that 3 dilutions are all that can safely be made for out-door work.

In Jars.—A large number of tests were made in jars, with very minute quantities of powder on both worms. Jars were covered. These were very successful, causing death in from forty minutes to two hours. The only exception to this was a full-grown larva of *brassicæ*. In this test dilutions up to twenty times the weight of powder were quite efficacious on *rapæ*, but a few of the last did not destroy *brassicæ* with certainty.

This series was also repeated in breeding cages with, in the main, corroboratory results. After 5 dilutions its action on *brassicæ* was quite uncertain, depending somewhat upon the amount used; 15 dilutions would not kill them at all under any method of treatment. *Rapæ* was killed up to 20 dilutions if thoroughly applied, although in such cases they were more severely treated than would be possible with powder bellows in field work. Experiments with minute portions of

pure powder would indicate that it is not the amount of powder that proves fatal but that it is the fact of a few grains of powder coming in contact with the body of the worm. All of my dilutions above 5 times the weight of powder show that its efficiency is thus very much impaired, and I am satisfied that while almost infinitesimal doses are sufficient to produce death when powder is pure, they will not suffice in the presence of adulterations. I am quite convinced that 5 dilutions is the limit of safe adulteration, and think that I should hesitate to recommend over 3. The age of the worm when treated is of considerable importance in this connection, as young worms are destroyed with much greater certainty than older ones. Pure powder exposed on the leaves of cabbage plants for periods of thirty minutes, fifteen hours, and twenty hours, killed with as much certainty as fresh powder. Old powder, which had stood one year in a candy jar without cover, killed as well as fresh powder. This last was used, diluted 3 times, in field work and did good execution.

One pound of powder diluted with 3 pounds of flour and carefully used in a Woodason double-cone bellows was sufficient to dust one acre thoroughly. Four was the only adulteration used.

EXTRACTS OF PYRETHRUM.

Water extract—1 ounce pyrethrum; 1 pint water.
Alcholic extract—1 ounce pyrethrum; 1 pint alcohol.

These were thoroughly tested and the tests repeated several times, with very unsatisfactory results.

The water extract was made by stirring together the ingredients. Only the liquor was used which was kept in a tightly closed jar.

This extract destroyed *rapae* at an average rate of 50 per cent. up to 4 dilutions, and at 5 dilutions failed entirely. In full strength it was not nearly so efficacious as dry powder, even on *rapæ*, and it did not affect *brassicæ* at all.

The alcoholic extract was made by repercolation with about 80 per cent. alcohol. This I anticipated would bear a large number of dilutions, and it was used in an extensive series of tests in the cages and jars. Up to 5 dilutions it killed fairly well and a few were destroyed above this, but not enough worth mentioning, only a small or weak worm dying. This test was repeated several times and a new extract was made, but with little better results. The new extract killed about 50 per cent. very slowly at 10 dilutions. Both extracts spoken of above were applied as spray, except that in jars a feather was used and the worms thoroughly wetted.

On Aphis brassicæ.

Pyrethrum in several forms was used on this insect with unsatisfactory results, the action being, when applied pure or in strong mixtures,

to dislodge but not destroy them. Pure powder applied with a bellows quickly dislodged them, but did not kill over 10 per cent. Those not killed soon recovered and crawled back upon the plant.

On Potato Beetle.

Used in the field pure it destroyed about 50 per cent. of the larvæ, principally younger ones. Adults were not injured though heavily treated, but when confined in breeding cage and thoroughly dusted they were all killed. I am quite sure pyrethrum is not a satisfactory remedy for Potato Beetle where London purple or Paris green can be used with safety.

On Tomato Worms.

Several species of Sphingids were quite numerous on the tomato vines, principally *quinque-maculata*. On these the powder was used pure and also diluted three times. I did not observe an instance where thoroughly applied that it did not produce death in from two to three days.

On Squash Bugs.

Diabrotica vittata and also 12-*punctata* were treated with the powder both pure and diluted three times. It destroyed them very effectually, although I am not certain that they could be so successfully treated in the spring when the plants are small and the beetles very active. This treatment was late in the season when they were feeding on pollen in the bloom of squashes.

On Fall Web-worm.

Not enough of these could be found for thorough tests, but pure powder used on one colony made them immediately break from the web, fall to the ground, and scatter in all directions, but two days' observation failed to show any dead ones.

Several times woolly caterpillars were treated both with powder and solution without in any instance producing death.

The powder used throughout was the *roseum*, and from one package.

BUHACH (*Pyrethrum cinerariæfolium*).

I was ordered to obtain this powder direct from dealers, and finally sent to Stockton, Cal., for it. It did not arrive in time for full comparisons with *P. roseum*, but I tested it quite thoroughly on *P. brassicæ*.

Used in minute particles it kills in one to three hours, was decidedly slower in action than *P. roseum*, but the weather was cooler. Exposed on leaves of plants it killed up to three days' exposure though very slow at last trial. Weather cool as before mentioned.

Diluted with flour it kills in small jars up to 30 dilutions, but in cages was not effective after 10 dilutions, and I think most of these

would have recovered had they been where they could have crawled away to fresh leaves. The season was so late when received that I was unable to give it a test out of doors with anything like satisfaction.

Alcoholic extract.—One ounce powder, 4 fluid ounces alcohol (repercolated).

This killed slowly at 10 dilutions; above that was not effective.

BENZINE.

This was used on several insects. Early in the season when the *rapæ* worm was plenty a large number of infested plants were sprayed with very unsatisfactory results. Where it was used lightly not 1 per cent. of worms was killed, used heavily a few more were killed, but the plants were also slightly injured. Tests in the field were repea ted several times with no better results. A number of tests were made in breeding cages and there they resisted it equally as well. Of one lot, after being thoroughly sprayed four times in quick succession, only 16 per cent. died. It usually sickened the worms, but they soon recovered. Of the lot above mentioned two had pupated in twenty hours. Only by the most thorough drenching was I able to kill cabbage worms at all with this remedy. The injury to leaves was not nearly so great as at first would be supposed, and in fact only extremely heavy applications did any lasting injury.

On Potato Beetle.

Thorough spraying did not injure these at all. Leaves were not injured.

On Tomato Worms.

The most thorough treatment was unavailing. Leaves slightly injured.

On Squash Bugs.

Were not injured. Leaves slightly burned.

On Cabbage Lice.

These were destroyed where the spraying was thoroughly done.

ALUM WATER.

This was first used in solution of 1 ounce to 1 quart of water, but as this had no effect whatever on cabbage worms or lice a strong solution was made by boiling water with a quantity of alum in it. Part of the alum crystallized out on cooling, but left the solution as strong as could be made. This was used very thoroughly with no result whatever. In every respect it was a complete failure.

ICE WATER.

This was used in spray and poured upon the plants in quantity, also worms were submerged in the water for periods of time up to ten seconds. Every trial showed this to be utterly valueless as a remedy. Occasionally a small worm would be injured but in no case that I observed were any killed outright. Temperature of water during trials varied from 35° to 38° Fah., air from 90° to 95° Fah. A hot day was purposely selected for the work.

TANSY WATER.

Strong decoctions of this were made both by soaking and boiling the leaves. In both cases it was apparently as strong as could be made. Used in the field, no result whatever. On worms confined in closed jars they died in about six hours. In cages no effect whatever, though tested repeatedly and very heavily applied.

TOMATO WATER.

A strong decoction of this was made by boiling and used as above with quite similar results. In many instances the substance has destroyed the worms in jars (small wide-mouth bottles) and not under exposed conditions. The larvæ were not drowned but only moistened. This is important as showing that the manner of using a substance is quite important.

DREER'S INSECT TERROR.

This powder was used both in the field and in cages. In no instance of the field trials were any of the larvæ injured, though it was thoroughly applied, lightly with bellows and heavily by hand. Used in cages it had no effect whatever except that in one instance 20 per cent. of *rapæ* were killed where it was applied to food so heavily as to completely coat it over. *P. brassicæ* was not affected by its use though confined from four to five days where food plant was completely coated with powder. I feel perfectly safe in saying, after abundant tests, that this substance is perfectly worthless.

HAMMOND'S SLUG SHOT.

This was used only on Cabbage Worms (*rapæ* and *brassicæ*). In field tests several hundred plants were used and tests made very thoroughly. At first the powder was dusted on lightly and was almost an entire failure, but with repeated and heavier dustings better results were obtained; however none of the results were sufficiently successful to commend its use. Where used heavily not over 20 per cent. of *rapæ* were killed, and *brassicæ* were not injured. In none of the field tests was I able to find dead *brassicæ*. Worms of both species were frequently

noticed forty-eight hours after application feeding as usual though themselves and the leaves were coated with powder. In breeding cages better results were obtained. Light applications did but little good as outside, but heavy applications, where plants were completely covered with powder, were quite effective, both species being destroyed to the extent of 80 per cent. to 90 per cent. (No substance was more carefully or thoroughly used than this in the above experiments.) In solutions the effect was about the same. It was used up to 8 ounces to 1 pint of water, making almost a thick mixture. In this manner about 25 per cent. of *rapæ* were killed in the field; not tried in cages.

All of my work points to the conclusion that *brassicæ* is more difficult to deal with than *rapæ;* especially is this true where the poison is a powder to be eaten. They are easily disturbed and will move away to the under side of the leaves until disturbing cause has disappeared.

This powder cannot be successfully applied with a bellows, because of its characteristic of accumulating in little balls or masses which cannot pass the bellows, and, also, it must be applied heavily to accomplish any results whatever. Heavy applications by hand will probably prove the only means of doing any good with it.

TOBACCO SOAPS.

Of these several were used, Wolf's Vermin Soap and different brands from the Rose Manufacturing Company, of New York, known as sulfo-tobacco soaps. Also two brands made by the above company were sent me by the Division, viz, a soda and a potash tobacco soap. These two packages seem not to be the same grade of goods the company at present manufacture, as evidenced by the difference in strength shown by my tests. The samples sent by the Rose Company were a plain and scented soda soap and a scented potash soap. The sample of Wolt's soap was received from the Milwaukee Soap Company, Milwaukee, Wis. It is a stiff soda soap strongly scented with tobacco and very offensive to handle. The potash soaps above mentioned were much softer than the soda soaps. They all dissolved readily at 100° Fah., and the Rose soaps remained in solution, but the Wolf's soap solidifies the whole solution even when very weak, forming a jelly-like mass. This is a very objectionable point if this soap is desired to be used as spray, as it necessitates heating every time before using.

On Cabbage Worms.

The two samples received from the Division were thoroughly tested on both species previously mentioned in this report. The solutions were made of different strengths up to 4 ounces to 1 pint of water, at which strength the soda soap destroyed slowly but thoroughly all larvæ of both species, and the potash soap was sure death to all larvæ which came in contact with it. These solutions improved with age as did all the soap solutions.

Of the samples received direct from the Rose Company the plain and scented soda soap were of the same strength, the only difference being that the scented soap is much more pleasant to handle. This and the potash soap were of about equal strength and destroyed readily all larvæ where thoroughly applied in solution of 1 ounce to 1 pint of water.

These soap solutions were used in a large number of tests which were duplicated several times, and in the strength stated gave good satisfaction, and are, I think, among the best liquid, non-poisonous applications I have ever used.

Wolf's soap, in solution of 2 ounces to 1 pint of water, did fairly good execution, but was not safe at that strength. In most of the tests it was used 4 ounces to 1 pint of water, at which strength it was sufficient to destroy all worms. After standing for two or three weeks the jelly formed by this soap when first dissolved breaks up into liquid, and its destructive power seems to be enhanced.

On Cabbage Plant-lice.

The Wolf's soap and the two samples received from the Division were used on the lice in several strengths, and one-half ounce to 1 pint was perfectly efficient, destroying all lice immediately. The samples received from the Rose Company direct were not used on lice, but their efficiency on *rapæ* and *brassicæ* would indicate that they would bear still greater dilution.

The circular of the Rose Company is, I think, quite misleading where they state that the essential principle of their soaps is a gum taken from tobacco in an aëriform condition and condensed in a vacuum. The only destructive principle which I am aware is contained in tobacco is a liquid alkaloid (never solid) known as nicotine. It is my opinion that the destructive effect of all these soaps, when used on the bodies of worms or soft insects, is entirely due to the caustic principle of the alkalies used. Potash, being the strongest alkali, will, I think, give best results where used in equal quantity with other alkalies. I proved to my entire satisfaction that none of these soaps are poisonous when eaten on the food plant. Of course, insects will not eat them readily. (A sample of carbolic-acid soap was used in various strengths without any results whatever.)

SEVERAL REMEDIES IMPORTED FROM LONDON.

These were used only on Cabbage worms. The results were entirely unsatisfactory.

The whole series of tests were conducted in breeding cages. The quantities used were double what directions advised, and the tests were repeated several times: Moore's compound, in solutions of one-half ounce to 1 ounce in 1 pint of water: Only two worms killed after several trials. Fir-tree oil solutions of 1 to 2 teaspoonfuls in 1 pint of water:

During repeated tests two worms were killed. Gishurst, in solutions of 1 to 2 ounces in 1 pint of water: This sickened many worms, but only three were destroyed. Bridgeford's Antiseptic, used pure, sickened the worms and destroyed several.

These remedies were entirely worthless. They are of foreign manufacture, and are not specially recommended for cabbage worms, but are advertised as insecticides of great merit; hence my notion of testing them on cabbage worms.

REPORT ON OHIO INSECTS.

By WILLIAM B. ALWOOD, *Special Agent.*

LETTER OF TRANSMITTAL.

COLUMBUS, OHIO, *October* 21, 1886.

DEAR SIR: I forward to-day a few pages of notes on insects observed during the few months I have been at work.

Yours, very truly,

WM. B. ALWOOD.

Prof. C. V. RILEY,
U. S. Entomologist.

THE STRAWBERRY LEAF-BEETLE.

(*Paria aterrima.*)

This insect began about the middle of August to feed upon the foliage of the strawberry beds in the University garden. It was first noticed upon the old beds, but soon spread to the new ones, and has done considerable damage, in some places completely riddling the leaves with its minute round holes. At the present date (October 12) it is yet busily at work.

THE STRAWBERRY ROOT-BORER.

(*Graphops pubescens.*)

Since the 1st of September the larva of this beetle has been doing considerable damage to the strawberry beds, attacking both old and new beds, and in some spots destroying as many as 10 per cent. of the plants. The grubs are found in numbers varying from two to eight per plant either in or near the roots. They work all the way from the crown to the lower part of the roots, eating in slight channels, which are left full of chips and castings. The grubs never, so far as I have noticed, bury themselves deeply in the fleshy part of the root, but prefer to work along the sides. Frequently a dead plant may be taken up whose roots show their work plainly, yet none of the larvæ are present in it. Examination of the soil around the plant will, however, reveal the little fellows. I have observed a great number in position feeding. Up to date (October 20) no pupæ have been found.

THE STRAWBERRY CROWN-BORER.

(*Tyloderma fragariæ.*)

This insect has done slight damage to one old bed. I have not in a single instance observed them in young beds.

THE PLANTAIN CURCULIO.

(*Macrops* sp.)

This insect was received from Medina County, the first specimens arriving July 21. With them came several specimens of plantain which were so thoroughly tunneled by the little grub that they had died. There were from two to six grubs in a single plant, and they completely exhausted the fleshy portion of the root. From this lot, received July 21, several adult beetles issued August 7. These were left in the cage several days, and I think must have deposited eggs on fresh plantain growing in the cage, as several days later, when examining this cage preparatory to cleaning it up, I found several young larvæ in the fresh plantain I had put in the cage on receiving first supply. These were observed closely. They pupated August 25 and issued September 3 to 4. Another lot of specimens was received August 6, placed in a different cage, began pupating 16th and issued 25th to 29th of August. From the account of the gentleman sending them they were quite destructive over a limited area.

A NEW OAT FLY.

(*Oscinis?* sp.)

This insect was discovered while visiting the northern part of Union County, some 50 miles from Columbus, to investigate another insect which had appeared in the wheat. (This insect proved to be *Meromyza americana*, and was confined to a very limited area, though it took the plants clean so far as it went.) The date of this visit was June 15, and the farmers had first noticed the attack upon the oats about June 9. The oat plants were 6 to 8 inches high and where attacked appeared as though a fire had swept over them just low enough to scorch the upper blades. Eggs and larvæ were both present at this time as described in my letters. The injury was confined to spots of several rods in dimension, but several fields in the neighborhood were affected. At my last visit, June 25, I estimated the damage to be about 40 per cent. in spots affected. A quantity of the plants were brought home and placed in breeding cage. On June 20 the first imagos, two in number, issued. From this cage they issued afterwards almost daily until July 7.

On my second visit I also brought home material in which larvæ and pupæ were quite abundant, but found no eggs. Flies issued from this batch in great numbers up to July 12.

THE CABBAGE PLANT-LOUSE.

(*Aphis brassicæ* L.)

This insect was quite troublesome this season from about the 1st of August to 1st of September. After the latter date they could only be found in scattering colonies. During the worst period of attack they were so plentiful as to nearly ruin many plants.

I mention them more for the purpose of speaking of the insects which preyed upon them than anything else.

Of these the larvæ of the Syrphus flies (two species were reared) were the most persistent and literally swept the lice off by thousands. It was very interesting to watch these blind maggots in their work of destruction. There were also present the larvæ of Lady-birds and Lace-winged flies. These, however, did not do anything like the execution of the first-named insects. I noticed where lice were very numerous that a large per cent. became winged, while on other portions of the field it seemed that a much larger per cent. were apterous.

CABBAGE WORMS.

(*Plusia brassicæ* and *Pieris rapæ*.)

August 3 a few larvæ of *brassicæ* were noticed in a patch of a couple of acres of Cabbage where *rapæ* were already quite abundant and doing considerable injury. They were so few that it was hardly thought possible they could do much harm the present year. On this date the *rapæ* as above stated were already numerous and doing much harm. A series of experiments was at once begun looking towards their destruction. However, many of this brood pupated, and from the 10th to the 15th of August I never saw the *rapæ* butterfly so abundant as they were over the cabbage beds in the University garden. These deposited their eggs in great abundance, and after several days disappeared. Among the first brood of worms (*rapæ*) I had noticed a few larvæ affected by *Apanteles glomeratus*, and also several pupæ which had been stung by *Pteromalus puparum*. These did not appear to be abundant, but probably many were not noticed. As this second brood of *rapæ* developed it was hardly possible to find a larvæ not affected by one of these parasites. *A. glomeratus* was most abundant, as it stings the young larvæ, but should one be so fortunate as to escape this insect, *P. puparum* was sure to find it. I noticed that the last named always stings the larva just before it makes the last molt or immediately after the pupa is formed. So well did these parasites do their work, that after the large brood of butterflies previously mentioned not an adult was seen except that now and then a straggling individual would sail over the field. In all of my experiments in boxes, during which I con-

fined a great many worms for days at a time, not a healthy pupa of *rapæ* was formed.

Neither of these parasites nor any other affected the *Plusia* in the least.

About August 20 the *Plusias* began to appear in greater numbers, not formidable as yet, but so numerous that I began to collect them in separate cages for experiment. From this time on until the 1st of October this insect multiplied at an astonishing rate. About the middle of September a late bed of cabbage, of perhaps a little more than one acre, which had almost escaped *rapæ*, was found to be literally alive with these larvæ, from ten to forty or fifty being found on a single plant. They destroyed it very rapidly, until the gardener put a man under my direction to kill them, which was done very successfully. The moth was not observed to move about at all during daytime, but was frequently found hidden among the leaves of the plant. When disturbed it flew rapidly in a zigzag manner and soon alighted.

It deposits its eggs irregularly over the lower side of the leaf, varying from a few in number to twelve or twenty. This habit makes it a worse enemy, in my estimation, than *rapæ*, as they deposit their eggs singly, and never in my observations do they happen to get so many on one plant as *brassicæ* does. The latter, from my observations, is much the more prolific, and is also more hardy.

THE CORN APHIS.

(*Aphis maidis.*)

The only injury I have ever known to be done by this insect occurred this year, about 6 miles northeast of this city. A gentleman planted his corn early in May. The weather was quite favorable, and it came up promptly and looked well for a few days, and then began to turn yellow and wither away. On examining he found what he rightly called a "small louse" in great abundance, and associated with it a great many small ants. He could not conclude that the louse was the cause of injury, so laid it to the ants. The injury became so great in a few days that he concluded to plant the field all over again, which he did with a two-horse check-row planter. This planting was taken the same as the first, and the field again planted over. This last planting was not much injured, and with the remnants of first two plantings made quite a crop. On the 11th of July, being in the neighborhood, my attention was called to the field. I still found the Aphis present in considerable numbers, but the corn was doing fairly well. A large number of insects were examined, yet none but apterous forms were observed. The first field is black-loam bottom-land, extending partly up on upland, lying beside a creek of considerable size; it is well drained, and the soil is loose and friable.

THE CLOVER-SEED MIDGE.

(*Cecidomyia leguminicola.*)

Quite serious complaints came to me concerning this insect, principally from counties lying north of the central portion of the State. It was not noticed at all in this vicinity, and so far as I know has never been found here or in the southern part of the State. Last year it was quite destructive in the same region reported from this year.

Definite facts as to extent of injury were not to be obtained, yet good farmers reported it as destroying a large part of the crop in their sections.

THE MAY BEETLE.

(*Lachnosterna fusca.*)

The larva of this beetle has destroyed a large portion of the sward on the university campus during the present summer. The attack began some three years ago and has become worse each year, until this season a large part of the lawn was left bare and brown, not even the first growth of bluegrass coming to maturity. From the spots where attack is most severe the sod can be rolled up in bundles. Clover is not injured and is consequently spreading spontaneously over the lawn. Examinations frequently showed as many as a dozen grubs to the square foot. There were three broods plainly to be noted; the two-year and one year were the most numerous, there being comparatively few grubs from eggs laid the past spring.

A large number of examinations showed no case of disease. Grubs began descending to winter quarters about September 20, but October 20 there are yet quite a number to be found. They were reported at work in lawns and strawberry gardens from many localities around the city, but were nowhere so numerous as here.

PTEROMALUS PUPARUM AND APANTELES GLOMERATUS.

A few observations on these two parasites may be of interest. Many specimens of each were bred. *P. puparum* issued on an average in fifteen days from date of ovipositing. From one pupa of the Cabbage Worm I bred fifty-two flies and from another one hundred and eleven. These last issued in just sixteen days from the time the females oviposited. This I considered a remarkable number to issue from one pupa, but of the fact there is not the possibility of a doubt. I observed three of the females ovipositing in one larva on the afternoon of August 24. These I watched for some time, intending to take the larva when they had done with it, but as they were still at work late in the afternoon I marked the spot and visited it the next morning to find a pupa formed. From this issued the flies, as noted above. In two instances

where I disturbed females the flies hatched ten and twelve in number, respectively, and were all females.

I was not able to take the females of *A. glomeratus* in the act of ovi positing, as they seem very sly. Several times I thought I caught them in the act, but was not sure. After pupating they were eight to ten days before issuing. They issued from twenty to possibly fifty in number, although I was never positive of breeding more than thirty-eight from one specimen.

This parasite did much more good than *P. puparum*, as it seemed to get the first chance.

APANTELES CONGREGATUS.

This insect was very destructive to the Sphingid larvæ on tomatoes. There were no less than four species of these worms, of which *Macrosila quinque-maculata* was most abundant. All were attacked, scarcely any escaping. I took one hundred and eighty cocoons from the body of one worm.

A RECORD OF SOME EXPERIMENTS RELATING TO THE EFFECT OF THE PUNCTURE OF SOME HEMIPTEROUS INSECTS UPON SHRUBS, FRUITS, AND GRAINS, 1886.

By F. M. WEBSTER, *Special Agent.*

LETTER OF TRANSMITTAL.

LA FAYETTE, IND., *October* 15, 1886.

SIR: I herewith give results of my experiments with Hemiptera, principally *Lygus pratensis* L.

F. M. WEBSTER.

Prof. C. V. RILEY,
U. S. Entomologist.

The object of the following experiments was to determine the effect of the punctures, or the withdrawing of sap from shrubs, the juices from berries, and the milk from ripening grain; and if possible to settle the point as to whether or not these Hemiptera, in thus partaking of their food, eject a poisonous saliva into the wounds which they necessarily produce, and thereby cause the death of the punctured object.

All insects were confined upon these shrubs, fruits, and grains by means of a sack of Swiss muslin, drawn over the object and tied, the stem being protected from undue pressure by cotton placed in the mouth of the sack.

EXPERIMENT 1.

Pœcilocapsus quadrivittatus.

May 22, a number of adults were confined upon two or three inches of terminal portions of a young pear shoot.

Result.—Within one week the shoot withered, and afterwards the leaves and buds died, and turned black as far down as the muslin sack extended, but below that point no effect was noticeable. Later, after the insects had also perished, new leaves were put forth within the sack.

EXPERIMENT 2.

Lygus pratensis L.

May 20, placed adults on shoots of Concord grape.

Result.—May 28, no effect could be noticed.

EXPERIMENT 3.

Lygus pratensis L.

May 25, confined adults on young shoots of Gooseberry.
Result.—May 30, no effect perceptible.

EXPERIMENT 4.

Lygus pratensis L.

Tried same experiment as No. 3, leaving adults on shoots for twenty days.

Results.—Same as in the preceding. Insects all dead.

EXPERIMENT 5.

Lygus pratensis L.

June 25, placed twelve adults on young shoots of Pear.

Result.—July 10, both the insects and that portion of the shoot upon which they were confined were dead. The plant withered and turned black, as in Experiment No. 2, but in this case died.

EXPERIMENT 6.

Lygus pratensis L.

May 21, placed a number of larvæ on a Charles Downing strawberry which was just turning to the white color which precedes the final red or ripe color.

Result.—May 28, berry fully ripe and uninjured. Not "buttoned." Several larvæ dead, and one advanced to pupa.

EXPERIMENT 7.

Lygus pratensis L.

May 25, placed ten pupæ on nearly full-grown Crescent strawberries.

Results.—May 31, berries no larger than when insects were placed on them, but are withered and prematurely ripe. No indication of "buttoning." Some of pupæ dead; others now grown to adults, alive and active.

EXPERIMENT 8.

Lygus pratensis L.

May 26, placed larvæ on a half-grown Sharpless strawberry.

Result.—June 7, berry not more than half as large as when insects were placed upon it; withered and black. Five of the larvæ now pupæ and still alive.

EXPERIMENT 9.

Lygus pratensis L.

May 29, placed twelve larvæ and pupæ on three Crescent berries, varying from less than one-fourth to about one-third grown.

Result.—June 6, all three berries withered up, black, and dead. In one case only was there any indication that, had the berry continued to grow rapidly, a buttoned berry might have been formed. A few insects alive and either in pupal or adult stage.

EXPERIMENT 10.

Lygus pratensis L.

May 31, placed twelve larvæ on cluster of three Crescents, respectively one-fourth, one-third, and one-half grown.

Result.—June 7, cluster killed.

EXPERIMENT 11.

Lygus pratensis L.

May 31, placed four larvæ on a one-third grown Crescent.
Result.—June 6, killed also.

EXPERIMENT 12.

Lygus pratensis L.

May 31, placed fourteen larvæ on a one-third grown Crescent.
Result.—June 4, killed.

EXPERIMENT 13.

Lygus pratensis L.

June 1, placed ten larvæ and pupæ on a one-third grown Downing.
Result.—June 5, withered and drying up.

EXPERIMENT 14.

Lygus pratensis L.

June 1, placed nine pupæ on a rather more than half-grown Kentucky.

Result.—June 11, this berry made some growth after insects were confined upon it, and exhibits a tendency to "button," which, however, might or might not be due to the attack of the bugs. At this date the insects were all dead, although several had reached the adult stage.

EXPERIMENT 15.

Lygus pratensis L.

June 1, placed seventeen pupæ on a nearly full-grown Kentucky.
Result.—June 5, dried up.

EXPERIMENT 16.

Lygus pratensis L.

June 1, placed six pupæ on a less than half-grown Kentucky.
Result.—June 7, killed.

EXPERIMENT 17.

Lygus pratensis L.

June 1, placed six pupæ on Kentucky of about the same size as the preceding.

Result.—June 7, seriously withered.

EXPERIMENT 18.

Lygus pratensis L.

June 5, placed five pupæ on a one-fourth grown Jersey Queen.

Result.—June 21, berry seriously injured by being dwarfed, and it appeared to wither instead of ripen, although the plant was frequently watered. No indication of "buttoning." Insects dead, but they had lived to reach the adult stage.

EXPERIMENT 19.

Lygus pratensis L.

June 5, placed four pupæ on Jersey Queen as near as possible like the one used in Experiment 18.

Result.—June 21, berry attained nearly full growth, not deformed, except by a few slight depressions in surface which could not be said to indicate buttoning. Does not look as fresh and healthy as those not under experiment. Bugs dead, but as adults.

EXPERIMENT 20.

Lygus pratensis L.

June 5, placed three pupæ on Jersey Queen of same size as the preceding.

Result.—June 14, berry smooth, ripened in normal condition, and seems uninjured. The insect escaped from this after being confined upon it for about one week.

EXPERIMENT 21.

Lygus pratensis L.

June 5, four larvæ had, for several days previous, been clustered upon a Jersey Queen about the size of those used in the three preceding experiments. These bugs are now confined upon the berry.

Result.—June 21, being ripened in perfect condition, so far as form and freshness are concerned. Was a very little smaller than No. 20. Insects all dead, except one, which was in last larval stage.

NOTE.—During June, 1885, three larvæ, to all appearances of the same species as the preceding, took up their abode on a full-grown Crescent and remained there, voluntarily, until the latter was fully ripe, the young bugs being observed to feed upon the juices. No injury to the berry was in any way apparent.

EXPERIMENT 22.

Calocoris rapidus Say.

June 8, confined four adults on as many heads of Fall Wheat, placing two insects together upon each two heads of grain, and covering as with the berries.

Result.—June 24, kernels as plump as those ripening freely in the fields. The insects died some time between the 16th and 24th.

EXPERIMENT 23.

Euschistus fissilis Uhl.

June 8, placed same number of adults upon same number of heads of wheat and in same manner as in Experiment 22.

Result.—June 24, a few kernels badly shrunken, but these do not amount to over 6 per cent. Bugs now dead, but were alive up to the 20th.

EXPERIMENT 24.

Lygus pratensis L.

June 8, placed four adults as in the preceding experiment.

Result.—June 24, kernels do not differ from those grown elsewhere in the field. One set of insects died on or about the 12th, the others between 16th and 20th.

EXPERIMENT 25.

Siphonophora avenæ Fab.

June 8, placed a number of adult females on heads of wheat as in the preceding.

Result—June 24, kernels shriveled, discolored, and nearly worthless,

NOTES FROM MISSOURI FOR THE SEASON OF 1886.

By MARY E. MURTFELDT, *Special Agent.*

LETTER OF TRANSMITTAL.

KIRKWOOD, MO., *December* 1, 1886.

SIR: I submit herewith the more important of my notes on the injurious insects of this locality, for 1886.

MARY E. MURTFELDT.

Prof. C. V. RILEY,
U. S. Entomologist.

Climatically the past season was characterized by excess of moisture during May and June, followed by unusual drought and heat throughout July and August. That these extremes had a certain effect on the development of insect life is not to be questioned, and, in a general way, may be attributed to them the unusual numbers of all sorts of leaf-feeding and sap-sucking species early in the season, and a corresponding dearth of Lepidoptera and some families of Coleoptera later in the year. So great was the scarcity of nocturnal Lepidoptera in August and early September that one might sit evening after evening in a brightly-lighted room with open windows and not a single moth would appear.

Tenthredinid larvæ were especially conspicuous during May and June. These included not only such familiar pests as the Rose, the Raspberry, and the Cherry slugs, the Birch and Willow False caterpillars, but several species on Ash, Oak, Elder, White-fringe, &c., which I have not yet reared to the perfect state. A peculiar and interesting species, determined by Professor Riley from the larvæ as *Lyda cerasi*, appeared in large numbers, in July, on Wild Cherry. This is a gregarious webworm, and its colonies covered quite large branches with their brown, viscid webs, in which were mingled the castings and exuviæ, forming, altogether unsightly and disgusting masses, which greatly disfigure the trees.

Another species of somewhat unique habit bores the new shoots of Roses, and for the past two years has proved quite injurious, especially to Hybrids and Teas. Its effects may be seen, late in June and early in July, in the blackened stems and withered leaves of the second growth, and the consequent destruction or prevention of the midsummer blooming. The larva is one-third of an inch in length, when full grown, by about one-twelfth inch in diameter, nearly equal throughout, except that it tapers abruptly toward the head. Color cream white,

immaculate. Surface finely wrinkled transversely, but without piliferous warts or pubescence. Head small, round, amber-yellow with dark-brown, triangular or V-shaped spot on each side. Anal plate orbicular, slate-gray. Thoracic legs same color as general surface; prolegs imperfectly developed. It bores from the tips of the shoots downward for an inch and a half or two inches, devouring everything but the cuticle and packing the frass at the upper end. When full grown it makes its exit through a round hole which it cuts at the lower end of its burrow, and, entering the earth, incloses itself in a tough, silken cocoon, in which it remains dormant until the following spring. The single fly which I have thus far succeeded in rearing issued in May, and is of the same size and very similar in appearance to the common Rose Slug fly (*Selandria rosæ*). Professor Riley says of it that "it appears to belong to the genus *Ardis* of the *Selandriidæ*."

Climbing Cutworms were a prominent feature of the entomological developments of the spring. These attacked the Oaks, Elms, and other shade trees, as well as Apple, Pear, and Cherry trees and a variety of vines and shrubs. Among the species detected in their work of destruction were *Agrotis saucia*, *A. scandens*, *A. alternata* and *Homohadena badistriga*. The grass under shade and fruit trees would often in the morning be thickly strewn with leaves and buds that had been severed during the night. This was especially noticeable under the various Oaks and Sweet Cherries. On a large, isolated specimen of the latter, up which a Trumpet vine had climbed, I took early in May a great number of the larvæ of *Agrotis alternata*. These mottled gray worms were found during the day extended longitudinally on the trunk, closely appressed to the stems of the Trumpet vine, where, protected by their imitative coloring, it would be impossible for an unpracticed eye to detect them and where even birds failed to find them. When ready to transform they descended to the earth and inclosed themselves in an ample, tough, dingy-white cocoon, under any slight protection that might be convenient. I also took this species from crevices of oak-bark and occasionally found one feeding in a rose.

Canker Worm (*Anisopteryx vernata*, Peck).—Not for several years has this pest appeared in such numbers in the orchards of this locality as during the past spring. Nor did the apple trees seem to recover from the excessive defoliation during the remainder of the season. The worms were especially numerous on trees around which the soil had not been stirred for a year or more.

I noted this year a habit of this insect that has not, to my knowledge, been previously recorded, viz, that the worms, with great regularity, desert the leaves during the middle of the day and hide in the forks of the branches and on the trunk in crevices and under loose scales of the bark. As I did not at once discover this propensity in these larvæ, it puzzled me for some time to account for their scarceness

about noon, whereas in the mornings and evenings the foliage would be crowded with them. Happening one day, while standing under an apple tree, to detach a loose scale of the bark I was surprised to find more than a dozen of the worms on the under side stretched out side by side in a close cluster. An examination of the bark revealed the fact that almost every scale harbored a larger or smaller company of the worms. Nor was there any evidence of their having sought these retreats merely for the purpose of molting, as they were of all sizes and ages, and besides an examination a few hours later disclosed them rapidly looping themselves up into the tree, as though in haste to begin their nightly banquet. Observation for several successive days established the fact of their habitual desertion of the foliage during the hottest hours of the day and of their return to it as evening approached. As the infested trees had not been smoothed for some time, and the trunks were rather "shaggy," advantage was taken of this discovery to have them cleaned about noonday and thousands of the sluggish worms were thus scraped off with the scales of bark and burned.

The Codling Moth was more than usually destructive to the apple crop throughout the West, destroying in many localities fully 75 per cent. of the fruit, and in not one orchard in a hundred were any measures taken to destroy the pest or prevent its spread.

The Broad-necked Root-borer (*Prionus laticollis*, Drury) proved considerably destructive to young nursery stock in some parts of the State. In some sections of young apple trees sent me it was found to have worked up into the trunk for a distance of 4 or 5 inches.

Leaf-hoppers of various kinds were noticeably abundant during midsummer. Of these, two species of Fulgorids, *Flata conica*, Say, and *Poeciloptera pruinosa*, Say, attracted much attention on shrubs and herbaceous plants, some of which were seriously injured by them.

The former species I observed chiefly on Osage Orange and Lilac. The larvæ are scarcely distinguishable from those of *P. pruinosa*, being of the same bug-like form and greenish-white color and thickly covered and surrounded by the white-tufted, sweetish secretion peculiar to the group. The pupæ of the two species differ widely, that of *pruinosa* retaining the pale color and flattened form of the larva and continuing to cover itself with the fibrous exudation. The pupæ of *F. conica*, on the contrary, assume an angular, humped, somewhat beech-nut-like form, a grayish-brown color, and a more horny texture, while the white secretion is limited to two feathery tufts at the tail. The perfect insect of this species is a deep yellow-green, and with its broad moth-like wings and crimson eyes it is a beautiful object. It is always gregarious, but especially so in its perfect state, and I have often seen shoots of the Osage Orange crowded with this insect ranged in close ranks for a distance of 18 inches or 2 feet and presenting a most unique and not unattractive appearance. The *pruinosa* species is somewhat smaller and is

also pretty in its powdery suit of pearl-gray and white. It attacks almost all kinds of vegetation; but was found last summer to be especially destructive to the foliage and stalks of the Dahlia in one garden in Kirkwood, injuring the plants beyond recovery. As it inhabits the under side of the leaves, for the most part, and its punctures cause these to curl somewhat, it is difficult to reach it with insecticides, but applications of air-slacked lime and spraying with an infusion of Pyrethrum will kill or dislodge it.

Halticus pallicornis is becoming every year more of a pest in this locality on Clover and many kinds of garden plants. Its punctures cause the leaves to turn yellow and present an appearance similar to those infested by Red Spider.

The Flea-like Negro-bug (*Corimelæna pulicaria*) also this year attacked Compositæ and Hollyhocks with great virulence.

Acoloithus falsarius—a congener of the well-known *Procris americana*—appeared on all varieties of the Grape in July in such numbers as to merit some attention from the economic entomologist. The larvæ are not found in companies feeding in regular ranks, as is the habit of *P. americana*, although several are often seen on the same leaf. This species feeds exclusively on the upper surface, gnawing off the parenchyma in irregular patches. The handsome little larva, when full grown, is about three-eighths of an inch in length by rather more than one-eighth inch in diameter. The form is depressed, almost rectangular. The surface is velvety and prettily checkered in dull orange or fulvous, yellow, and two or three shades of purple. Medio-dorsal line fine, interrupted, dark purple, on each side of which is a broad stripe of orange outlined in pale yellow, the dark color being most intense in the center of each square, where, under the lens, is situated a little tuft of silky hairs. The lateral stripe is similar, but contains a larger proportion of purple. A purple band extends transversely across the fourth and ninth segments. The depth of this coloring is quite variable, some larvæ being very much paler and less distinctly variegated than others. The under surface and legs are translucent, velvety, white, with a tinge of green. Head very small, brown and retracted under the projecting edge of first segment. It incloses itself when ready to change in a fold of a leaf or between two leaves in a flat flesh-tinted silken cocoon covered externally with lime-like granulations. The moth escapes in about two weeks and is dull black with orange collar like *P. americana*, but it is considerably smaller than the latter. A slight dusting with Pyrethrum powder caused the larvæ to drop from the leaves, and this will probably prove one of the best remedies where this insect has become unduly abundant.

The Saddle-back Caterpillar (*Empretia stimulea*) is known to feed on a variety of trees and other plants, but I have seen no record of its occurrence on Soft Maple.

Late in August of the present year I found quite a colony, probably ten or twelve, on a single leaf of the above-mentioned tree. They had but recently hatched, but tiny as they were—not more than an eighth of an inch in length—they had all the tubercles and other characteristics of the mature larva, except that the saddle-cloth-like spot was deep yellow instead of green and the central dorsal spot pinkish-gray. They had perforated the leaf with small irregular holes. Not thinking that they would readily loosen their hold on the leaf, I carried it carelessly in my hand, and when I reached the house was much disappointed to find that but two larvæ remained on it. As these thrived and perfected their development to the point of inclosing themselves in cocoons, it is evident that Maple may be included in the list of their food-plants.

The Cottony Maple Scale (*Pulvinaria innumerabilis*). This insect has not been troublesome in this part of Missouri since 1884; but in and around Rockford, Ill., I learned that it had been so abundant on the Soft Maples for three successive seasons as to kill many young trees outright and greatly injure the older ones. I was told that the sidewalks shaded by these trees became so defiled and slippery from the exudations of the scale insect that it was difficult and unpleasant to walk on them. The citizens had consequently conceived a prejudice against the Soft Maple, and many were being cut down or dug up and replaced by other trees.

A new Leaf-bug on Maple (*Lygus monachus* Uhler, n. sp.).*—This bug came under my notice for the first time late in the spring of 1882 infesting the growing points of young Soft Maples (*Acer dasycarpum*). Most of the insects were at that time mature, but two or three pupæ were found, enough to indicate that the leaves of the maple had been their breeding place. A few specimens were taken, but, as the insect was not present in sufficient numbers to give it importance as an injurious species, not much attention was paid to it. During several succeeding springs I occasionally came across a mature specimen—which, from its exceeding agility, both in running and flying, generally evaded capt-

* Mr. Uhler has given us the following description of this new Lygæid:

LYGUS MONACHUS n. sp.—Long-oval, pale green or testaceous, coarsely punctate above, sericeous pubescent. Face convex, highly polished, bald; base of vertex with a longitudinal impressed line, towards which a similar line runs obliquely each side from the inner corner of the eyes; antennæ sparsely and minutely pubescent, basal joint thickest, a little longer than the head, tapering at base, second joint thrice as long as the basal, infuscated and a little enlarged towards the tip, third and fourth setaceous, together not as long as the second. Pronotum highly polished, convex, coarsely punctate in transverse wavy lines, each side with a dark brown vitta, or long spot; lateral margin smooth, callous at base, the humeral angles subacute, callosities prominent, convex, almost confluent on the middle; lateral flap of pronotum irregularly punctate. Pectoral pieces pale, impunctate. Legs pale green, feebly pubescent; apex of posterior femur usually with one or two fuscous bands, tip of tarsi and the nails black. Scutellum moderately convex, excavated at base, transversely obsolete-punctate, more or less infuscated. Corium coarsely, transversely rostrate-punctate, the clavers more or less infuscated, sometimes with all but the

ure—but it was not until the present season that the maples were infested to such an extent as to injure and disfigure them.

Just as the leaves were beginning to put forth, close observation revealed the fact that they were all more or less stippled with transparent spots, some mere dots, others a tenth of an inch or more in diameter. As the leaves expanded the delicate cuticle of the upper surface would give way and they presented the appearance of being perforated with holes and much torn and tattered along the margin, marring their beauty for the entire season. If, about the 1st of May, the leaves were carefully examined, there would be found on the under surface of each from two or three to a dozen or more very delicate bugs of a very pale translucent green color, the embryo wing-pads being almost white. They were further characterized by very long and slender legs, beak and antennæ, body flat and broad oval in outline; head small, eyes relatively large, oblong and bright red-brown in color. The larvæ varied in size from one-twentieth to one-eighth inch in length, and so far as I could discover there were but two larval molts. Scattered about over the leaves were small, round, translucent green eggs rather larger than a Portulaca seed. The pupal form was precisely like the larval, except in point of size and relative development of the wing-pads. When the under side of a leaf was turned up for examination the bugs, large and small, would dart, on their hair like legs, to the reversed surface, moving with the greatest rapidity and sometimes dropping to the ground in their evident desire to escape observation. The final transformation occurred about the middle of May, after which the companies dispersed. The species is a pretty one, although, from the glassy texture of the entire hemelytra and the general delicacy of coloring, it always has a somewhat immature appearance.

This bug happily lacks the disagreeable odor so common to the species of this suborder and which pertains even to most of its closest allies.

Absence from Kirkwood after the middle of May somewhat interrupted my observations on this insect. On my return, early in June,

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margins covered with dark brown; corium usually with a transverse, dark-brown arc next the posterior border; cuneus long and wide, the incised base fuscous, and the inner margin brown; membrane pale testaceous, with two or more dark clouded spots, the inner submargin of the principal areole, a spot at its tip and the base next the cuneus all more or less fuscous. Venter pale greenish.

Length of body, female, 5^{mm}; to tip of wing covers, 7^{mm}; width of pronotum, 2^{mm}.

Male, length of body, 4^{mm}; to tip of wing covers, $5\frac{1}{2}^{mm}$; width of pronotum, $1\frac{3}{4}^{mm}$.

This has proved to be a very common insect in various localities.

Mr. Cassino collected numerous specimens around Peabody, Mass. Mr. Bolter sent to me a pair from Illinois and Missouri; and I have taken it from Alders, Maples, and many other kinds of small trees and shrubs on Cape Ann, Mass., also near the base of the White Mountains, and in New Hampshire, and near Quebec, Canada.

Mr. Forbes has also forwarded to me specimens from near Normal, Ill.

It resembles *Lygus invitus* Say, and presents several of the color varieties common to that species; but it is a much larger insect, of a longer figure, and has a more flattened upper surface.—P. R. Uhler.

only a few of the mature bugs remained among the curled and torn leaves on which they had developed. Occasionally throughout the summer a specimen would be met with, as often on the foliage of any other tree as on maple, but there was no second brood. This species, unlike *Capsus oblineatus*, is never to my knowledge found on flowers. It probably secretes itself early in the season and becomes dormant until the following spring.

The only remedial applications experimented with were Pyrethrum powder and air-slacked lime, both of which were measurably effective, judging by the small scale on which they were tried.

APICULTURAL EXPERIMENTS.

By NELSON W. MCLAIN, *Special Agent.*

INTRODUCTORY NOTE.

The following article is extracted from Mr. McLain's annual report for 1886, the major part of which is published in the Annual Report of the Department for that year.

C. V. R.

PREPARING BEES FOR WINTER.

Bees instinctively begin to make preparations for winter somewhat earlier in the season than is commonly supposed. In preparing for winter, as in all other matters relating to bee-keeping, the apiarist should see to it that the method of management is as nearly as possible in agreement with the instinct and habits of the bee. When bees build their combs after their own design, as in box hives, spaces are left between wide enough to admit of elongating the cells in order that a large share of the winter stores may be placed in the top of the hive, easily accessible in the severest weather. I find it good practice to widen the spaces between the comb-frames near the close of the honey-gathering season, in order that the bees may, by elongating the cells, place a large share of the winter store above the cluster.

As soon as the storing of surplus honey is done the condition of every colony should be examined, the amount and character of the winter food ascertained, the number of comb-frames, and the size of the apartment should be determined by and adapted to the wants of each colony. After the supply of winter stores has been equalized among all the colonies, if the supply is insufficient, feeding should be done before the advent of cold nights.

Bees expected to perform the function of hibernation should not be too old nor yet too young. Both queen and worker bees should be in full physical vigor. The bees constituting the colony, when placed in winter quarters, should be such as are hatched after the midsummer working season is past, and before the bees cease flying freely in the fall.

Towards the close of the working season the workers instinctively cease stimulating the queen for oviproduction; gradually the bees cease flying, and the cluster is formed for winter. After the cluster is formed the colony should remain undisturbed. If the bees are to be packed on the summer stand the work should be done with care, and without dis-

turbing the bees, and before the temperature at night reaches the freezing point. If the bees are to be placed in a damp or in cellar or winter repository, great care should be taken not to disturb the cluster when the hives are removed from the summer stand. I have found woolen quilts or woolen blankets the best covering for winter. Wool, better than any other material which I have tried, prevents the radiation of heat, and permits the escape of moisture, thus securing warmth and dryness. Hives should be placed 18 inches above the bottom of the cellar or winter repository, and in tiering them up one above another it is better that they rest on a rack prepared for the hive rather than one upon another.

My report for 1885 covers the period from June 1 to November 25, when the severity of the weather forbade further out-of-door experiments. As nearly all the colonies in the apiary had been subjected to very frequent, almost daily, disturbance and annoyance incidental to the experimental purposes for which they had been used, they were, almost without exception, in very poor condition for passing into winter quarters. November 25 I packed twenty colonies for out-door wintering. Notwithstanding the lateness of the season, and the altogether unsatisfactory condition of the bees when packed, eighteen of the colonies wintered fairly well. These twenty colonies were provided with dry sawdust packing 8 inches thick on the sides, and covered with a quilt and dry forest leaves to the depth of 8 inches on top of the frames. A rim 2 inches wide is placed under the body box of the hive, making a 2-inch space under the bottom bar of the comb-frames. A covered tunnel leads from the hive entrance through the packing. This packing is left on the hive until warm weather is assured, thus guarding against danger from chilling of the brood when building up the colonies rapidly in early spring. The hive should incline from back to front permitting the moisture to flow out at the entrance.

I placed ten colonies in the cellar from which the hive covers were removed and the frames covered with woolen and cotton quilts. These were used for observation and experiment during the winter. Eight of the ten came through the winter alive, but being subjected to a wider range of temperature, and being very frequently annoyed and disturbed, their vitality was very low, and the old bees, of which most of these colonies were composed fell easy victims to spring dwindling.

HIBERNATION.

For the purpose of determining the degree of temperature in a dry cellar necessary to secure the minimum of functional activity within the hive during the period of hibernation, I framed comb-frames across each other at right angles, and into these frames I fitted and fastened combs filled with choice sealed honey. These were suspended in hives having glass sides and top, exposing the cluster to view from all sides and from the top. Removable wooden doors covered the glass.

My observations covered a period of ninety days from December 1, 1885, and included a range of temperature from zero to 65° F. The hives were placed in a dark apartment, and an oil stove with a radiator was used for heating. Different degrees of temperature were maintained for several consecutive hours, and, as occasion required, for consecutive days, and careful observations were taken.

At a range of temperature from 48° to 52° F., according to the humidity of the atmosphere in the cellar, bees, according to a rule of nature, enter into the hibernating state. After repeated trials over a wide range of temperature, at 41° F. I found the shape of the cluster most permanent. While that degree of temperature was maintained, little change in the shape or location of the clusters could be seen, and functional activity on the part of individual bees, and of the whole colony as well, seemed to have reached the minimum degree of manifestation, even respiration seemed to be suspended. The change in the form of the cluster was determined by outline drawings on paper. The colonies presented substantially the same outline for days together when a uniform temperature of 41° was maintained. I placed some colonies in a darkened building late in the fall of the year, and when the temperature was 40° F. natural heat on a dry day above ground, the same phenomena were observed.

The temperature of the cellar was lowered by admitting the air through an outer room, so that no perceptible currents entered the apartment where the bees were kept. The degree of unrest and activity increased in proportion as the temperature neared the zero point. Thirty-seven degrees F. in a very dry cellar is a danger point, the danger increasing in proportion as the temperature is lowered or the humidity of the atmosphere is increased.

The degree of activity shown by bees when the temperature in the repository or cellar is 44° F. is not much greater than at 41°, all other conditions being the same.

At intervals of about one week the bees arouse to activity, the form of the cluster changes, and after three or four hours of cheerful and contented humming, having in the mean time appeased their hunger, the cluster is reformed into a compact body, the humming ceases, respiration becomes slow, profound silence reigns in the hive until change of temperature or the demands of hunger rouse the bees from the coma in which they have been bound. The more perfect the conditions for hibernation the longer the periods of inactivity.

As the activity of bees is not much greater when the temperature in the cellar or repository is steadily maintained at 44 degrees than it is at 41 degrees, and as 41 degrees is too near the danger point, I find it safer to keep the temperature in dry winter repositories, whether above or below ground, at 44° F., and I find it better that the variation from the standard degree of 41° F. should be in proportion of 2 degrees above rather than 1 degree below. If the repository be damp a degree

of temperature higher in proportion to the dampness should be maintained. The hive should incline from back to front, and the entrance should be left wide open.

It has been the practice of many to raise the temperature in winter repositories in order to stimulate breeding toward the close of the hibernating period. I have tried this, and in my experience I find it better to maintain as nearly as possible an even temperature until the bees may be safely placed on the summer stands. What is gained in early breeding is more than lost in the waste of vitality on the part of the older bees. In the case of bees wintered on the summer stands or in a clamp, the packing of dry forest leaves, chaff, or sawdust placed above the quilt should be closely packed about the edges, and should be from 7 to 12 inches in thickness. Indeed it would be difficult to get the packing above the cluster too deep, provided the ventilation above the packing is sufficient to carry off moisture.

SPRING DWINDLING.

For preventing spring dwindling, and building up colonies to maximum strength and efficiency at the beginning of the working season—for success in honey-producing largely depends on having strong colonies ready for work at the very time when efficient work may be done—I prepared a bee-food containing the elements essential in brood-rearing. This food is prepared after the following formula:

To 10 pounds of sugar I add half a pint of dairy salt, 2 tablespoonfuls bicarbonate of soda, 2 tablespoonfuls rye flour, 2 tablespoonfuls finely powdered bone-ash, and 1 tablespoonful cream tartar. Mix thoroughly, then add 2 quarts hot water, and stir until thoroughly dissolved, and let the mixture boil, but only 2 or 3 minutes. I feed this food in the hive as honey or sirup is usually fed, thereby keeping all the bees at home to aid in keeping up the temperature in the hive, thus reserving their vitality for performing the functions of brood-rearing, instead of speedily wearing out their remaining strength in roaming the fields in search of the elements essential to larval growth.

The bone ash is prepared by burning dry bones to a white ash, which I pulverize and sift through a sieve made from fine wire strainer cloth. As this food is not intended for use until after the bees have had a good flight in the spring, almost any grade of sugar or dark low-grade honey may be supplied for brood-rearing.

The rapidity with which a colony consisting of a mere handful of bees may be built up to full strength and working efficiency by using this preparation is surprising. Only as much as is needed for immediate consumption should be frequently supplied, and it should be fed only to prevent spring dwindling, or when it is desirable to quickly increase the numerical strength of the colony in anticipation of a honey harvest, or to recruit the vigor and strength of the colony by rearing young bees after the working season, and prior to going into winter quarters.

BEES VS. FRUIT.

I have, according to your instructions, repeated my experiments of last year for testing the capacity of bees, under exceptional circumstances, to injure fruit; adding such other tests and observations as the very severe and protracted drought permitted. The house used last season, 10 feet by 16 feet in size, having sides partly covered with wire cloth and large screen doors in each end, was used again this year. Two colonies of Italian bees, two of hybrids, one of Caucasians, and two of Syrians were confined in this house.

These colonies were without food in their hives and at intervals of three or four days were fed a little sirup for the purpose of keeping up their vigor and to prevent dying from starvation. A wood-stove was placed in the house and a high temperature was maintained for a number of hours each day.

The conditions incident to an unusually severe and protracted drought were present within and without. The bees were repeatedly brought to the stages of hunger, thirst, and starvation, the test continuing for 40 days.

Through the favor of Mr. T. T. Lyon, president of the Michigan State Horticultural Society, I obtained thirteen varieties of choice grapes from A. G. Gulley, of South Haven. Every inducement and opportunity was afforded the bees to appease their hunger and thirst by attacking the fruit which was placed before them. Some of the bunches of grapes were dipped in sirup and hung in the hives between the the combs, some placed before the hives on plates, and grapes were suspended in clusters from the posts and rafters. The bees lapped and sucked all the sirup from the skins, leaving the berries smooth.

They daily visited the grapes in great numbers and took advantage of every crack in the epidermis or opening at the stem, appropriating to their use every drop of juice exuding therefrom, but they made no attempt to grasp the cuticle with their mandibles or claws. I removed the epidermis carefully from dozens of grapes of various kinds and placed them on plates before the hives. The bees lapped up all the juice on the outside of the film surrounding the segments of the grape, leaving this delicate film dry and shining, but through and beyond this film they were not able to penetrate. I punctured the skins of grapes of all kinds by passing needles of various sizes through the grape and placed these before the bees. The needles used were in size from a fine cambric needle to a packing needle. The amount of juice appropriated was in proportion to the size of the opening in the skins and the number of segments of the grape broken. The same was true in the case of grapes burst from over-ripeness. Bees are not only unable to penetrate the epidermis of the grape, but they also appear to be unable, even when impelled by the direst necessity, to penetrate the film sur-

rounding the berry even after the epidermis is removed. Grapes so prepared without exception laid before the hives until dried up. If but one segment of a grape be broken by violence or by over-ripeness, the bees are unable to reach the juice beyond the film separating the broken from the unbroken segments until further violence or decay permits an entrance for the tongue. Clusters of sound grapes which I hung between the comb frames in hives occupied by strong colonies were unbroken and sound after fifteen days' exposure in the hives. The skins were polished smooth, but none were broken. I also stopped up the entrance to several hives—containing good-sized colonies—in the apiary and in the wire-covered house, by pushing sound grapes into the opening, so close together that the bees could not pass through. By this means the bees were confined to the hives for days in succession, not being able to break down and remove the grapes, and although the skins of the grapes next the inside of the hive were polished smooth none were broken or injured.

The past season furnished an excellent opportunity to observe the capacity of bees, under so exceptional circumstances, to injure fruit, for the drought was very exceptional both in duration and severity, and I was called to several places by fruit-growers to witness the proof that bees were "tearing open the skins of the grapes" and otherwise behaving in a manner altogether unworthy of an insect enjoying a wide reputation for virtue and orderly living. In each instance I succeeded in convincing the fruit-grower that the bees were simply performing the office of gleaners; that violence from other sources, or over-ripeness and decay had preceded the bees, and that he would be acting the part of wisdom in following the example of the bees in gathering the grapes before further violence, or the action of the elements, rendered them worthless.

After grapes have been subjected to such violence, or have so far burst open and decayed as to make it possible for bees to injure them, and the circumstances are so exceptional as to lead the bees to seek such food, unless they are speedly gathered they would soon become worthless if unmolested. During the past season I made many visits to vineyards, one located near the apiary I visited every day, and my observations and experience with bees in confinement and those having free access to the vineyards furnishes abundant proof to convince me that bees do not and cannot under any circumstances injure sound fruit. If from any cause the pulp is exposed, such as the attack of birds or wasps—the most common source of injury—or from the ovipositing of insects, or bursting of the berry from over-ripeness, and if no other resources are available, the bees appropriate and carry away the juice, and the extent of the injury depends upon the degree to which the pulp is exposed, the sweetness of the juice, and the number and necessities of the bees.

BEE FORAGE.

If excellence in the bee is the chief factor in successful honey producing, next in logical order is abundant, persistent, and cheap bee-pasturage. Abundant pasturage is the amount necessary to satisfy the requirements of the number of colonies kept within a given area. Persistent pasturage is that which contemplates a variety of perennial honey bearing flora of hardy constitution and rugged habits whose terms of blooming follow each other in succession continuously from early spring to late fall, thus lengthening out the season in which bees may gather surplus honey. Cheap bee-pasturage may be such as is furnished from natural sources produced in forests or by self-propagating plants growing in waste places or upon lands of little value and requiring little or no labor. Or cheap bee-pasturage may be secured by cultivating fruits and field crops, the blossoms of which are valuable for honey bearing.

As the forests of the country disappear and the waste lands are being reclaimed, as the necessity for other honey-producing resources is felt, as the industry assumes more importance and as the influence of competition is more sharply felt, great interest is shown in the subject of bee-pasturage. The number of days in each year in which bees can gather and store surplus honey will not average, except in exceptionally favored localities, above thirty or thirty-five days; the remaining time and energies of the bees being employed in gathering sufficient for the sustenance of the colony, and enforced idleness or non-productiveness. Enforced idleness, and the consequent waste of time, stores, and energies sometimes result from a failure of the flowers to secrete nectar, even though honey-bearing flowers are blooming in abundance, but usually the reason why the time is so short in which bees are able to store surplus honey is the lack of abundant pasturage. I have not had the time or the means to devote to bee-forage that the importance of the subject demands, but I have made a beginning in this department of experimental work which I hope to continue. Among all the trees and shrubs which are cultivated generally throughout the United States by fruit-growers, the raspberry is commonly conceded to possess more value to bee-keepers than any other. A quarter of a mile from this station a market gardener has 4 acres of raspberries. These bushes continued to bloom for ten days, and during that time, with the exception of two or three rainy days, a continuous procession of bees could be observed going and returning to and from the apiary, and a fine showing of honey was made in the hives and the honey was of superior quality.

On account of the superior quality of its nectar, the ease with which the plant is propagated, its adaptation to all kinds of soil and its value as a forage plant for grazing, white clover has, until of late years, stood without a rival in the estimation of honey-producers. About twenty years ago Alsike or Swedish clover was introduced into this country,

and since then has been thoroughly tested both as a honey plant and also for hay and pasture for all kinds of stock.

Mr. J. M. Hicks, of Battle Ground, Ind., says: "Alsike Clover has no superior as a honey-producing plant, yielding the best and richest honey known, and as a hay crop it is not surpassed, often producing 3 tons of good hay per acre. The stems and stalks are much finer than those of common red clover, and cattle, horses, and sheep feast on it, eating it clean without waste. As a pasture of all kinds of stock it has no equal. It will grow on all kinds of land, clay, or sandy, and does not freeze out as easily as red clover. It is quite similar to red clover in appearance. The first crop each season is the seed crop. The seed is about one-third the size of red clover and 4 pounds is sufficient to sow an acre. The bloom is a beautiful pale pink color. I have no hesitancy in saying that Alsike Clover will produce 500 pounds of the richest and best honey per acre in a good season. I would recommend every bee-keeper to sow at least a few acres of Alsike Clover." Mr. W. Z. Hutchinson, of Rogersville, Mich., says that it will pay to raise Alsike Clover for honey alone upon land worth $50 per acre.

Mr. C. M. Goodspeed, of Thorn Hill, N. Y., says: "I have grown Alsike on my farm and watched its habits closely. It is very hardy, of extra quality as hay and a heavy seeder, reaching in rare cases 10 bushels per acre. In this locality the second growth seldom yields much honey, but the first growth just swarms with bees for about three weeks, or from the time the rich blossoms open until the seed is ripe. In my locality it begins to yield honey shortly after white clover and continues well into the bass-wood season. It yields twice as much honey as white or red clover." Mr. D. A. Jones, of Beeton, Ontario, says: "I think too much can scarcely be said of Alsike as a hay and honey crop, and many of our farmers are waking up to the fact that it is to their interest to cultivate it largely in preference to almost any other crop. Red Clover will soon be a thing of the past, as Alsike seed is now in great demand, not only for seeding purposes but also for use in dyeing. I am informed that large quantities are being shipped to Europe for that use." Mr. A. I. Root, of Medina, Ohio, and Mr. L. C. Root, of Mohawk, N. Y., both speak of Alsike as the most valuable variety of clover for hay and pasturage and recommend its cultivation as being of the first importance to bee-keepers. Statements testifying to the unequaled value of Alsike Clover, both for hay and grazing purposes, and as a most valuable honey-bearing plant, might be indefinitely multiplied. I cannot too strongly urge the bee-keepers of the United States to provide abundance of this forage for their bees, both by sowing the seed on their own premises and also by inducing their neighbors to cultivate this variety of clover as the best for all purposes.

Sweet Clover (*Mellilotus alba*) abounds in this locality. This is a hardy plant, of wondrous persistence, continuing in bloom from about July 1 until killed by frost. It is adapted to almost any kind of soil.

In this part of Illinois it grows in rich soil by the wayside, or in deserted stone quarries with equal luxuriance. As the plant will grow without any cultivation in by-ways and waste places, wherever the seed can obtain a foothold, and is a perennial, it is rightly reckoned among the number of excellent and cheap bee-forage plants. Sweet Clover will endure drought well. During the long drought of last season bees in this neighborhood would have been entirely without resources for many weeks together had it not been for Sweet Clover. The quality of the honey is excellent, and under ordinary conditions the yield is altogether satisfactory. Much apprehension has been felt among farmers lest it become a noxious weed. Observing how readily the seed is carried in the mud on wagon wheels and horses' feet in the spring, when the roads are bad and the entire space in the highways is used for travel, belief has obtained that the fields would soon be invaded. Careful and continuous observation of the facts for five years past has convinced me that fears of trouble from this source are groundless. In but one instance have I seen Sweet Clover invade a plowed field, and that was for a distance of 3 rods on both sides of an old road leading into the field and the seed had been carried in on wagon wheels. This plant being a biennial is easily exterminated when desirable. I would recommend bee-keepers to provide abundance of this forage by scattering the seed in waste places and by the roadside. Sweet Clover is much more sightly and useful, and less objectionable, in every way, than the weeds which ordinarily cover the roadsides.

Pleurisy-Root (*Asclepias tuberosa*) is a honey-bearing plant indigenous to nearly all parts of the United States, but its growth has not been encouraged for the reason that its value to the honey-producer has not been generally known. The plant is a perennial; the top dies and rots, a new growth springing up each year. It is commonly regarded as a harmless prairie weed. The deep red blossoms hang in clusters. The plant is very hardy and of a rugged growth, growing luxuriantly in all kinds of soil. The honey is of the finest quality both as to color and flavor. Mr. James Heddon, of Dowagiac, Mich., speaking of Pleurisy, says: "If there is any plant, to the growing of which good land may be exclusively devoted for the sole purpose of honey production, I think it is this; I would rather have one acre of it than three of Sweet Clover. It blooms through July and the first half of August, and bees never desert Pleurisy for bass-wood or anything else. The blossoms always look bright and fresh, and yield honey continuously in wet and dry weather. Bees work on it in the rain, and during the excessive drought of the past season it did not cease to secrete nectar in abundance." I have had some observation and experience with the plant, and, having secured seed, I expect to test it in different kinds of soil next season.

For two years past I have cultivated a plot of Motherwort (*Leonurus cardiaca*), and I prize it highly as a honey plant. Bees work on it continually all day, and every day, unless it is raining quite hard. The

summer of 1885 it continued in bloom six weeks. Last summer it bloomed but was soon ruined by drought. At the annual meeting of the North American Bee-Keepers' Association held in Detroit in December, 1885, a committee, of which I was a member, was appointed by the association to investigate the merits of a new plant being cultivated by Mr. Chapman, of Versailles, N. Y., who was present and represented that the plant was of unusual value to honey-producers. Being instructed by you so to do, I met with other members of that committee at Versailles on the 28th of July. I herewith inclose a copy of the report which I prepared in behalf of that committee, together with a letter of Mr. A. E. Manum, president of the Vermont Bee-Keepers' Association, which I presented to the North American Bee-Keepers' Association at its annual meeting held in Indianapolis, Ind., October 12, 13, 14, 1886.

My experience with the plants furnished for observation at this station was nearly identical with that of Mr. Manum. Fifty-two plants arrived here by express, fifty-one of which came to maturity. Plants were furnished to Prof. A. J. Cook, Lansing, Mich.; T. F. Bingham, Abronia, Mich.; W. F. Clarke, Guelph, Ontario, and Mr. Van Dom, Omaha, Nebr., each of whom highly recommend it as possessing unusual value as a bee-forage plant.

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